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EXPERIMENTAL HUSBANDRY FARMS

EXPERIMENTAL HORTICULTURE STATIONS

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Experimental Husbandry Farms and Experimental Horticulture Stations

SIXTH PROGRESS REPORT

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Introduction

This is the sixth Progress Report on experimental work at the N.A.A.S. Experimental Husbandry Farms and Horticulture Stations.

The Report does not attempt to review the whole field of investigations in progress in any one year but presents a selection of topics of particular interest, either because they are new to the experimental programme or because they have reached a stage where conclusions of practical importance can be reported.

For a fuller account of experiments being undertaken, other publications are available. Each centre prepares an Annual Report written mainly for the farmer and horticulturist, which can be obtained from the Director concerned (address on pp. 67–69). In addition, at the conclusion of most experiments the results are reported in *Experimental Husbandry*, *Experimental Horticulture* or other scientific or technical journals.

Results from Recent Experiments

REARING THE DAIRY HEIFER

P. J. Jones, *Bridget's Experimental Husbandry Farm*

The choice of a suitable level of feeding for the dairy replacement heifer calf is the subject of a certain amount of debate. It is clear that very high or very low levels are generally detrimental and can for most purposes be discounted. There is, however, a wide choice within this range from feeding levels which produce a well proportioned sleek animal at six months of age having grown at a rate of some $1\frac{1}{2}$ to $1\frac{3}{4}$ lb per day, to the smaller, somewhat pot-bellied, heifer, which has been economically fed to grow at only $\frac{1}{2}$ to $\frac{3}{4}$ lb per day during the same period.

The choice is particularly relevant with autumn born calves; firstly, because they represent a large proportion of the national dairy herd and, secondly, because of the possibility of exploiting the phenomenon of compensatory growth during the 6–12 month phase when they can be at grass and may be expected to grow rapidly at low cost, especially if they have grown comparatively slowly during their calfhood winter.

Experiments have been in progress since 1956, at three Experimental Husbandry Farms, to compare the effects of two such contrasting feeding scales in terms of growth rates, health, eventual milk yield and longevity. Friesians were used at Boxworth E.H.F., Cambridgeshire, and here the planned comparison of growth rates was 1·8 or 0·9 lb per head per day in the first winter of the heifer's life; at Bridget's E.H.F., Hampshire, Ayrshires were used and a comparison of 1·4 and 0·7 lb per head per day was made, and at Trawscoed E.H.F., Cardiganshire, where the breed was Dairy Shorthorn, the comparison of growth rates was between 1·5 and 0·75 lb per head per day. At each farm, therefore, there was a comparison which may be referred to as High or Moderate plane of rearing. In order to build up sufficient numbers, some 8–10 calves were taken on to each plane of feeding in each of the years 1958–62 (Boxworth), 1957–61 (Bridget's) and 1956–61 (Trawscoed). Thus some 100 calves have now been reared at each farm, but since at least four lactations are required to give a reasonable assessment of yield and some indication of longevity, at the time of writing reliable information is available only for the first and second lactations. Complete data up to and including the fourth lactation will not be available until 1968.

Feeding during Calf Winter and Later Management

Calves were selected from autumn calving cows that had reached predetermined levels of production for the breed, and allocated to High or Moderate groups so as to equalize as many outside influences, such as that of sire and housing, as possible. Each year's intake was spread over as short a time as possible and in any case not more than two months.

At Boxworth the differential rates of feeding in the first two rears (1958 and 1959) were achieved by a combination of later weaning and a higher rate of concentrate feeding for high plane calves, but subsequently a five-week weaning age was used for both groups and differential growth rates achieved by increased rates of concentrate and hay feeding for the High plane calves.

In the 1958 and 1959 rears, High and Moderate plane calves received 90 and 27 gallons whole milk respectively; in later years, all calves received 27 gallons whole milk.

At Bridget's the differential growth rates were achieved by later weaning and a higher rate of concentrate feeding for High plane calves. These calves received about 41 gallons whole milk and milk substitute gruel until twelve weeks of age, and Moderate plane calves received about 19 gallons whole milk and Rowett early weaning mixture (without anti-biotic) during the same period.

At Trawscoed, the High plane calves were multiple-suckled and received about 95 gallons whole milk, and the Moderate plane calves were bucket-fed and received about 24 gallons whole milk. Growth rate differences were maintained by differential concentrate feeding for the two groups.

After the winter feeding period, all the calves were turned out to grass together in the same field and grazed together during the summer period. For the second winter period, all the heifers were yarded together as one group and all precautions possible were taken to avoid bullying and to ensure a fair distribution of food. Good store rations were fed during this period.

Growth Rates to First Calving

Naturally, the different levels of feeding had a marked effect on growth rates of the young calves, and at six months of age the difference in weight was between $1\frac{1}{2}$ and $1\frac{3}{4}$ cwt. (Table 1). Compensatory growth occurred when all the animals were given uniform and more liberal feeding while at grass, so that, at the first calving, the difference in weight was not very great and it was difficult to distinguish by eye between the two groups.

Table 1

Growth rates to first calving

Farm	*Number of animals*		*Liveweight at beginning of period* (lb)		*Live weight gain/day during period* (lb)	
	High	Moderate	High	Moderate	High	Moderate
	Birth to turning out (first winter)					
Boxworth	48	49	86	91	1·68	0·94
Bridget's	58	60	69	70	1·41	0·70
Trawscoed	48	48	81	79	1·50	0·78
	Turning out to yarding (first summer)					
Boxworth	48	49	514	328	1·04	1·53
Bridget's	57	60	343	214	1·08	1·20
Trawscoed	48	48	355	223	1·01	1·11
			At first calving			
Boxworth	19	19	1016	1004	—	—
Bridget's	32	38	950	910	—	—
Trawscoed	42	41	960	876	—	—

Measurements of girth, length of back and height of withers were also taken from each animal at specified intervals, which again illustrated that compensatory growth occurred resulting in only small differences at the time of first calving.

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TABLE 2

Milk production data (all animals)

	Number of animals		*Average yields per lactation* (lb)		*Length of lactation* (days)		*Mean B.F.* (%)		*Mean S.N.F.* (%)	
	High	Moderate	High	Moderate	High	Moderate	High	Moderate	High	Moderate
1st lactations										
Boxworth	19	19	6658	7439	251	270	3·42	3·39	8·79	8·84
Bridget's	31	35	7029	6603	240	236	3·99	4·03	9·02	9·03
Trawscoed	37	35	6554	7192	288	298	3·58	3·55	8·99	8·91
2nd lactations										
Boxworth	10	12	8040	8530	269	270	3·56	3·41	8·67	8·94
Bridget's	18	23	9492	7600	265	230	3·81	3·77	8·85	8·85
Trawscoed	26	25	6550	7756	232	280	3·48	3·49	8·96	8·81
3rd lactations										
Boxworth	4	6	9594	12146	285	294	3·51	3·19	8·61	8·68
Bridget's	7	15	7500	7382	226	217	3·53	3·77	8·59	8·74
Trawscoed	15	16	7488	8656	241	276	3·49	3·39	8·81	8·74
4th lactations										
Boxworth	—	—	—	—	—	—	—	—	—	—
Bridget's	3	5	8389	9500	227	262	3·75	3·60	8·68	8·68
Trawscoed	6	12	7040	7924	226	261	3·41	3·67	8·58	8·75

The average age of heifers when run with a bull varied to suit the particular farm and breed in question. With the Friesians at Boxworth this was at 15 months, to calve in the autumn at two years of age; at Bridget's and Trawscoed the bulls were turned in when the Ayrshires and Dairy Shorthorn heifers were between 18 to 20 months of age, so that they calved in late winter or early spring between $2\frac{1}{4}$ and $2\frac{1}{2}$ years of age. No attempt was made to achieve differential calving between the two groups of animals.

Lactation Records

All in-calf heifers were steamed up in the normal way and any heifers found not to be in calf were discarded from the experiment.

At Boxworth and Trawscoed the animals reared on the Moderate plane have given more milk in each lactation than those reared on a better level, and this difference increased with successive lactations (Table 2). But at Bridget's the pattern has not been so consistent, and the average yields for the first three lactations are in favour of the better reared animals. For the last lactation the same trend occurs as at the other centres, but the overall yields favour the High plane. The numbers of animals which have so far reached the third and fourth lactations are small, however, and this pattern could change as more animals reach this stage of the experiment.

BEEF FROM GRASS

J. M. Willcock, *Liscombe Experimental Husbandry Farm*

In 1960 over half the home-produced beef was slaughtered at two years or more, but by 1964 this proportion had reduced to 41 per cent. Much of this earlier slaughtering is due to the rapid adoption of the intensive rearing system. This has lead to a temporary increase in home-killed beef, but the effect of slaughtering at the lighter weights, combined with intensive rearing, has lead to a lowering of the overall level of beef output. The scarcity of rearing calves is a cause for concern, and in order even to maintain present output, some consideration has to be given to the possibilities of slaughtering at heavier weights than those currently accepted as economically possible under high concentrate feeding system. Tenderness found in the young animal is an essential quality, but this can be found in more conventional forms of rearing and fattening, which have the added advantage of retaining flavour.

Grass plays an important part in most farming systems for one reason or another. Systems of beef production are largely complementary to systems of farming. When it is possible to grow high yields of cereals, and desirable to have only a limited acreage of grass, then the beef production policy will involve using a comparatively high ratio of cereal feeding in the system. Even under such a system grass can play an important part, both by reducing feeding costs and obtaining a heavier carcass than would be economically possible under an all-concentrate system. In these circumstances, every attempt must be made to marry, to the best advantage, the merits of grass and home-produced cereals.

In other circumstances, such as in the more traditional rearing areas where grass plays a far more important role, the problem becomes one of making as much use as possible of the grass and the products conserved from it as silage or hay.

Studies concerning the utilization of grass in beef production are being undertaken at a number of Experimental Husbandry Farms. The farming situations vary, and although the principles are similar in most cases, the practice varies according to circumstances. This report covers some of the work at Gleadthorpe, High Mowthorpe and Liscombe.

Gleadthorpe is situated in a low rainfall area of about 24 inches on blowing sand soil. Here, as a long term policy, a proportion of grass is considered necessary to maintain arable production at a satisfactory level. High Mowthorpe on chalk and silty loams with an average annual rainfall of some 30 inches, and cereal cropping occupies more than 60 per cent of the farm acregage. Liscombe is an all-grass farm in a livestock rearing area with average rainfall of 60 inches.

The Autumn-born Calf

The majority of calvings in the national dairy herd occur during the autumn. Autumn born calves are reared at both Gleadthorpe and High Mowthorpe on an early weaning system. From weaning at around 5 to 6 weeks, a moderate level of 4 to 6 lb concentrate are fed daily with good quality hay or silage.

The calves are turned out as early as the season permits. This not only shortens the period of expensive winter feeding, but reduces the check which can result when cattle are turned into lush spring grass. Concentrate feeding is continued during this change over period of about three weeks usually up to the beginning of May.

Grazing management

At Gleadthorpe, with Friesian steers, the stocking rate is about 3 per acre, grazed rotationally, on semi-permanent pasture difficult to bring into the arable rotations. Nitrogen is applied at 100 units per annum.

At High Mowthorpe, a stocking rate of up to 2½ Friesian and Hereford × Friesian calves per acre is achieved under a rotational grazing system. Here silage forms an integral part of the system. The acreage required to supply the grazing needs of the calves in early spring is about one-third of the total area needed for the season, and the remainder is cut for silage in May. The vigorous aftermath growth supplies palatable high quality grazing in mid-season when the early-grazed land is in need of a rest. The level of nitrogen manuring is selected to regulate the amount of grass the cattle require. A complete fertilizer is followed by a top dressing of Nitro-chalk to give a total of 90 units of nitrogen applied before the cattle are turned out. A further 100 units of nitrogen, in 2–4 applications, are given during the grazing season. Although there has been a tendency to 'looseness', cattle have not taken harm and have continued to gain at about 2 lb per day.

Concentrate at grass

The effect of feeding a cereal mixture at grass was assessed at High Mowthorpe for two years. In neither year did the feeding of 3 lb corn per day prove to be economic before late August. During September and October, when grass quality was declining, supplementary feeding proved worthwhile (Table 3).

TABLE 3

The Effect of feeding concentrate at grass
(Mean of 1961 & 1962 results)

Period	Mean daily gain (lb)	
	With concentrates	Grass only
Turn-out to end August	2·2	2·0
September and October	1·8	1·3

Supplementary feeding at Gleadthorpe begins in late August and continues through the autumn. Chat potatoes up to 7 lb are fed on the grass together with straw and rolled barley or beet pulp rising to 4 lb daily.

Winter feeding

Cattle on both farms come into yards in early November at between 6 and 7 cwt. Those at Gleadthorpe are taken to around 10 cwt on a ration up to 16 lb barley with 40 lb silage daily. At High Mowthorpe, cattle are slaughtered at between 8½–9 cwt. The ration consists of 8 lb of a cereal mix, 25 lb of a high dry matter silage and 4 lb of hay.

Returns

These compare very favourably with cereal production. Gross margins at High Mowthorpe have, over three years, averaged £25 and £44 per beast. Carrying the cattle to heavier weights at Gleadthorpe has given a higher margin of £38 per beast, and as the grass required per beast is one acre, this figure also represents the margin per acre.

It is of interest to note the cost per lb of liveweight gain at grass on both farms is half, or less, than that during the period of yarding. The 2½–3 cwt gain during the grazing season at the low cost of 6d. per pound liveweight gain is largely responsible for this.

Outwintering

At Gleadthorpe there is not enough yard accommodation to house the number of cattle required to utilize all the 'summer' grass acres effectively. There is also some riverside grazing which would be difficult to plough and is rather 'strong' for six month old calves. Enough cattle are therefore required to make good use of this riverside grass in their second summer. These spend their yearling winter outside instead of in yards. Autumn feeding at grass is similar to that for cattle for earlier finishing. Later in the autumn sugar beet tops, kale drilled after early potatoes or foggage from leys rested after the second-cut silage, are available. The aim is to keep the cattle gaining at 1–1½ lb daily by feeding arable by-products and reserving the silage for use from January onwards. This type of management results in a strong store of 7–8 cwt by the time new grass comes in April. In previous experiments, cattle out-wintered on silage only made little or no progress in the winter. The feeding of 4 lb concentrates and pig potatoes with the silage and straw, ensures a

satisfactory winter performance and, when followed by 2–3 lb of beet pulp nuts at grass, has made it possible to market 22 month old cattle at $9\frac{3}{4}$ cwt off riverside grass in June and early July. This is before the prices begin to decline sharply. This system offers a useful alternative to the 18 month bullocks sold out of yards in April, but is not so profitable. The margin per head has been about £33, but since the acreage per beast amounts to two acres, the margin is reduced to £17 per acre.

The Spring-born Calf

On all three farms, experiments have been undertaken to examine ways of reducing the costs of rearing spring born calves by making use of grass in the first summer.

At High Mowthorpe several methods of getting Friesian and Hereford × Friesian calves out on to grass at very early ages have been tried, and the results compared with indoor rearing. The two most promising methods of rearing on grass were either, to turn the calves out on arrival and feed only with milk substitute, thereby encouraging very early grazing, or to early wean the calves inside, and turn them out one week after weaning. Both systems worked well in a season when weather conditions were favourable, but under cold wet conditions calves turned out on arrival did not thrive and the severe stress caused losses. The system of rearing inside and turning out with a maximum of 3 lb of early weaning pellets at grass up to twelve weeks after arrival is therefore favoured under the conditions that prevail at High Mowthorpe. During the rest of the summer a daily supplement of 1 lb rolled barley plus minerals is given to ensure adequate mineral intake.

At Liscombe, a similar system of rearing Devon × Friesian calves is used, the calves being turned out at about eight weeks of age. Concentrate feeding is continued until twelve weeks at approximately the end of May. From then (when around three months) until mid-October the calves are given no supplementary feeding. The acreage requirement in the early calf stage is small and the calves are stocked at eight per acre over half the area required during the grazing season. The other half is put up for a late May cut of silage. From mid-July the whole area is available for grazing. This overall density of stocking, at four calves an acre, has given approximately 800 lb liveweight gain and 2–3 tons of silage. Fertilizer input has averaged 100 units nitrogen and 50 units of phosphate and potash annually.

By the autumn, calves reared under this system weigh between 350 and 500 lb with an average of 400 lb. Purchased feed costs are low; for example, of the 100 calves reared under this system in 1964, the average consumption of milk substitute was 52 lb and concentrate feed, including early weaning mixture, was 202 lb.

On both farms the calves are rotationally grazed. Young calves are susceptible to parasitism; at High Mowthorpe first year leys which have not grazed cattle are preferred, or alternatively, older leys which have had a long rest from previous stocking with cattle. The problem of providing 'clean' pasture on an all stock farm such as Liscombe is more difficult. Here, preferably, the calves

graze pastures which have not carried cattle in the previous year, but calves have made satisfactory progress on one field which has been used for rearing in four consecutive years.

Wintering for 'baby-beef'

On all three farms, spring born calves reared at grass have gone on to a high concentrate system to finish as 'baby beef', between 12 and 15 months of age.

At Gleadthorpe, late January/February born Friesian steers have come in off grass at the end of September. The winter ration is based on equal parts of sugar beet pulp and barley to a maximum of 12 lb daily of the mixture, plus 35–40 lb of silage. By April the steers gain nearly 4 cwt in the yards to reach a live weight of $7\frac{3}{4}$ cwt.

Returns, including calf subsidy, have averaged £84 and food costs £46, leaving a margin to cover labour, overheads and profit of £23 assuming a calf cost of £15. By less intensive feeding, the rearing period was prolonged to 15 months, giving cattle comparable in type to 'barley beef' which were fit for sale during a period of good prices.

Using grass reared calves followed by an intensive system of feeding during the winter, a comparison of an all concentrate system with cereal plus silage feeding was made at Liscombe. Cattle on silage were fed 9 lb barley per day and took a month longer to get a similar degree of finish as those on an all-concentrate diet, but were nearly $\frac{1}{2}$ cwt heavier when slaughtered. It was found necessary to change to an all-concentrate system for the last four to six weeks of finishing. The gross margin per head was similar to that of the Gleadthorpe cattle, £24 as compared with £18 for the all concentrate finished beasts, but silage fed cattle do incur additional fixed costs in fodder production and extra labour during their longer fattening period.

At High Mowthorpe, the margin over calf and feed costs of grass reared calves finished on all concentrate, was £25 per head. A margin of £13 to £18 per beast has been achieved on the farm on the all-concentrate intensive indoor system.

Wintering for store production

Other than finishing under an intensive feeding system, spring born calves are not usually fit for slaughter off grass by 18 months of age and require a further period of yard feeding to attain a sufficient degree of finish. It is essential, in these circumstances, to rear as cheaply as possible especially during the first winter.

Winter performance was directly related to level of cereal supplementation, but it is necessary, with cattle destined to spend a further period at grass, to take into account performance over the whole period. The level of cereal supplementation necessary during the winter for optimum overall performance was found to be largely dependent on the quality of the silage.

With good quality silage, there was no economic response from feeding a cereal supplement. When silage of moderate quality was fed, a low daily supplement of 2–3 lb cereal was economically worthwhile. When silage feeding has been supplemented with a medium level of 6 lb or more cereal daily, no economic advantage has been obtained with any of the silages used.

TABLE 4

Effect of feeding cereal with silage
(Mean of 3 years results)

Type of ration and quantity fed during winter	*Value of calf in autumn @ £7 per cwt* £	*Cost of winter ration (barley @ £1 4s. per cwt) and subsequent summer grazing* £	*Value of store mid August @ £7 10s. per cwt. plus calf subsidy* £	*Margin* £
1. Silage only 56·6 cwt Silage	25·3	9·2	59·5	28·8
2. Silage + low level barley 51·8 cwt silage 4·6 cwt barley	25·3	14·4	63·0	26·9
3. Silage + medium level barley 48·6 cwt silage 8·5 cwt barley	25·3	18·8	64·6	23·9
4. Silage + high level barley 44·4 cwt silage 10·8 cwt barley	25·4	21·3	66·7	23·2

SUMMARY

There are some points of management common to all farms and to all systems. Turning out to grass for all age groups is as early as conditions will permit.

High quality grass is essential and the tools of grassland management, including rotational grazing, fertilizing, pasture control by topping and silage making, all play their part to this end.

All farms apply moderate to heavy applications of nitrogen both for grazing and for silage. High stocking rates to exploit the grass are employed.

Quality of silage is almost of equal importance to quality of grazed grass. When of high quality either better winter performance follows or a reduction in concentrates used.

With all forms of animal production and especially under more intensive systems, stockmanship is, without doubt, one of the most important factors of all.

MECHANICAL HARVESTING OF BLACK CURRANTS

T. Laflin, *Luddington Experimental Horticulture Station*

The post-war demand for black currants for juice extraction, and the long-term contracts which were made by growers to supply fruit for this purpose, increased interest in this crop which is our most important bush fruit. Problems in black currant growing being tackled on the Experimental Horticulture

Stations include pest and disease control, crop nutrition, irrigation and testing of varieties for growing and cropping ability, season and other characteristics. A substantial part of the cost of production is that incurred in picking. The hand picking of black currants, supervision of pickers, weighing of fruit into containers and transport in the field, cost approximately £40 per ton of fruit. An improvement in harvesting methods, by reducing this cost, could make a major contribution to increased profitability.

The Field Shaker

The first attempts to mechanize picking envisaged a manually-directed picking head, powered through a flexible lead, applied to branches on the growing bush. The picking head either shook the fruit from the branch or plucked it iff, using a specially designed plucking mechanism. The fruit fell either into a hopper placed under the bush or into a container attached to the picking head. There are difficulties with this approach. The flexible lead can be an embarrassment in a dense plantation; each head requires an operator and has to be guided between branches growing closely together which can slow down the operation; fruit has to be collected when it falls, and the conventional black currant bush is not of the best shape to position a hopper under it; and leaves picked with the fruit have to be removed in an additional operation. In spite of these problems one machine, the Berrymaster, using a shaking technique, has been developed with considerable success. The models marketed in 1964 were powered by compressed air, the compressor driven either from a tractor or an independent motor. Up to eight vibrating heads were driven by one compressor. The whole, mounted on a frame on wheels, with the longer airlines supported on swinging metal arms, could easily be pushed between rows of bushes at the normal 8 ft row spacing. The fruit was shaken into a hopper and, although not quite all was removed from the bush, it could be picked, in good condition, at all stages of ripeness. It was then poured from the hopper and fell, through a current of air blown from the compressor which removed the leaves, into the container in which it would be marketed. The final condition of the fruit was good. Using one operator on each of four heads, with one person servicing them, the quantity picked per person was about four times greater than with conventional hand-picking. Damage to the bush at the point to which the vibrator is applied to the branch, was negligible. A small, open bush of spreading habit, such as that of Wellington XXX, was the best for this method of picking.

The Static Picker

The manufacturer of the Bruff machine has worked on a different principle, similar to that of the hop-picking machine. This is a static machine and necessitates the cutting out of whole fruiting branches from the bush. These are taken to the machine and placed on an elevator, which conveys them to a chain gripping mechanism. This holds the branch by its lower end and carries it between moving pluckers, which strip the fruit and leaves from the branch. Fruit falls through a current of air, which blows away the leaves, on to a belt, which carries it to the container. The branch is discharged from the machine

at a height which enables a trailer to stand beneath, so that refuse can be easily carted away. The best organization for feeding the machine is for the bush to be cut down by hand and the branches placed, all in one direction, on a pallet. Loaded pallets are moved to the machine by means of a fork-lift on a tractor and placed on a short length of roller conveyor leading to the machine. Operators place the branches on a travelling belt, putting the butt ends in a clip, which keeps the branch in the right position for it to be gripped by the chain mechanism. Two cutters, one tractor driver, two feeders and one weighing fruit and disposing of pallets is the normal gang, with an additional person disposing of branches and fruit and aiding either cutting or disposal of pallets as necessary. Seven people have picked about 9 cwt fruit an hour, but this is well below the capacity of the machine, and studies in the organization of the work should give a much faster performance. The quality of picked fruit is good.

It is expected that it will be possible to design a mobile machine working on this principle. If it is developed, it will travel up the rows and the cutting of branches and their elevation into the picker will be mechanized. The inclusion of a flail-type shredder to reduce the branches to shreds, would allow them to be discharged back on to the land and eliminate disposal in more time-consuming ways.

The problem with this method is that of the result of cutting down bushes at picking time. There is no experience of this, although hard cutting and early pruning have both been done successfully. Bushes cut down in one year will not crop in the next, but will produce a crop every other year. This means a considerable crop reduction unless, in the year of cropping, consistently heavy crops can be taken. Since 1961, experiments have been in progress at Luddington E.H.S. to study the effects of doing this, both on growing methods and crops.

Pruning Trials

Two-year old bushes of the variety Baldwin were planted, 10 × 4 ft and cut down in March, 1960. Bushes were again cut down in winter, 1960, when the first trial commenced. The treatments were:

(a) hand picking fruit; normal winter pruning;
(b) all fruiting wood cut out for picking each year; growths of the current year left to fruit in the next year;
(c) hand picking in first year and no cutting out; treatment as in (b) in the second year;
(d) bush cut down completely for picking. As this produces a crop only in alternate years, the bush is cut down only in alternate years;
(e) hand picking in first year and no cutting out; treatment as in (d) in second and third years.

The first crop was picked in 1962. Treatments (a) (b) and (c) have carried a crop each year since and will continue to crop annually. Treatment (d) carried its second crop in 1964 and will crop again in 1966. Treatment (e) carried crops in 1962 and 1963, when it was cut down, to crop again in 1965.

Growth and yields of Baldwin were as follows:

Treatment	*Extension growth, total inches*		*Crop, tons/acre at 10 × 4 ft spacing*	
	1962	1963	1963	1964
Fruiting wood cut out each year	393	364	2·5	1·6
Bush cut down completely in 1962	—	1162	—	4·6
Winter pruned each year (hand-picked)	1200	1104	5·5	2·9

A similar trial with Wellington XXX, planted a year later, has given similar results in one year of cropping. The main points emerging so far are that the removal of fruiting wood for picking each year appears to halve the crop, whereas the complete cutting down and alternate year cropping reduces it to a far less extent. This appears to be the method which, on short-term results, shows most promise. It is stressed, however, that these bushes are young and the behaviour of a plantation treated in this way in later years has still to be worked out.

Spacing Trial

Complete cutting for mechanical picking offers the possibility of closer planting to increase crop per acre. A spacing trial, using Wellington XXX, was planted at Luddington in 1962 and the first crop has been taken. There are six spacings, 4, 6 and 8 ft between rows, and, at each inter-row spacing, bushes are spaced at 2 or 4 ft in the row. The closest spacing, 4 × 2 ft in beds 20 ft wide, with a 10 ft tractor alley between each bed, requires 3,630 bushes per acre, compared with the 1,360 bushes at 8 × 4 ft. In the first year of cropping, 1964, the crops per acre, adjusted to allow for the bed system with tractor alleys with the 4 ft inter-row plants, increased with the increase in number of bushes per acre, although not proportionately so. For example, 8 ft × 4 ft gave 4·45 tons per acre, 8 × 2 ft, 5·71 tons per acre, 4 × 4 ft, 4·9 tons per acre and 4 × 2 ft, 5·77 tons per acre. These cropping figures raise some interesting questions. If crops can be maintained at this level, the method has distinct commercial advantages, as it makes complete mechanization of harvesting possible.

With alternate year cropping, two approaches are feasible, The whole of the plantation can be treated in the same way in any year, requiring a bed system with close planting. The advantages are that cultural operations, particularly manuring and spraying, can be fitted to the growth phase of the plant and the width of the harvester is immaterial. The disadvantages are the density of the plant, with possible increase of diseases, such as botrytis, the difficulty of spraying and the loss of crop with one-third of the area used for tractor alleys. The alternative is to cut down alternate rows in alternate years. The fruiting bushes would be less dense and botrytis might be less of a problem. Trials so far suggest that crop per bush is unlikely to be heavier and, with spreading varieties, the growth habit is less suitable for mechanical cutting with wider spacing. Crop per acre will be heavier if the tractor alleys are unnecessary, but this depends on the possibility of running over the bushes,

in the year after cutting down, to harvest fruit from the alternate rows, which may not be easy. It may be more difficult to adjust manuring to a plantation where some bushes are in the growth phase and some in the fruiting phase, but spraying should be easier. These advantages and disadvantages are, at present, largely conjecture, but growers and experimental stations are comparing the systems.

Methods of Establishment

The larger bush numbers required for close plants encourage the establishment of plantations from direct-planted cuttings rather than from one or two year old bushes. Plantations have been successfully established from cuttings, but critical comparisons of the cropping from those established in different ways have not been made. An experiment put down at Efford in 1964 will compare this performance. The use of direct planted cuttings at very close spacings, e.g., 1 × 1 ft in 5 row beds, opens up the possibility of growing black currants as a two year crop. Cuttings inserted in October or November will fruit a year and eight months later and the plantation could be destroyed after picking the crop. This is being investigated at Luddington. An alternative is progressive thinning of a plantation planted in this way, so that the final plant would be more suited for a plantation of normal length of life. This might be of use in obtaining a higher crop in the early years of the plantation.

Effect on Pests and Diseases

Experience will show how pests and diseases will react to this new method of growing black currants. Big bud mite control may be easier with the use of more efficient acaracides, which it may be possible to use in the non-fruiting year when residues on the crop do not complicate the issue. The same may be true of leaf spot, where, in the growth year, a more complete programme may be possible. Leaf spot appears to be more severe, particularly early in the season on leaves on old wood than on those on young wood. With only young growth present the disease may be a smaller problem. But dense plants may favour diseases, particularly botrytis, and the effect of gooseberry mildew on the extension growth of bushes may be more serious, where the whole crop depends upon extension growth, than in a system where some of the crop is carried on older wood. Particular care will need to be taken with propagating material if the health of the plantation is to be kept at the high level necessary for heavy crops. The numbers of bushes or cuttings required may encourage growers more frequently to raise their own propagating material. The planting of cuttings in permanent positions for immediate cropping prevents inspection in the nursery and makes inspection in the field more difficult, as well as increasing the area to be inspected. This problem of maintaining the health of planting material can be a real danger if not recognized from the first and steps taken to ensure that this material is substantially free from big bud mite and reversion. Spraying methods in fruiting plantations will have to be adapted to dense plants. The N.I.A.E. are already interested in this problem.

Economics of Mechanical Harvesting

It is early to give details of costs of machine picking, but some assessment of the position must be made, although it must be clearly understood that the

basis for some of the figures is conjecture. The additional capital outlay is likely to be £1,500 for a machine, £150 for a fork-lift attachment for a tractor and pallets and an additional 2,000 bushes per acre, costing £80 per acre. If these costs are written off in ten years, and interest on capital charged at 6 per cent, the annual charge is £500. By the present method of hand cutting and carrying to a static machine on the headland, it is probable that, with a good crop, four men, three women and two tractors can feed the machine to pick $3\frac{3}{4}$ tons in an eight-hour day. Add to this the running costs of the picker, this costs about £6 per ton. With a picking season of 20 working days and a crop of 5·8 tons per acre, one machine will be sufficient for 26 acres, half of which is picked each year. On this basis, we may estimate costs as follows:

	£
Growing costs, 26 acres @ £84 per acre (no charge for pruning), per year	2,184
Annual interest and depreciation on machine and additional bushes for 26 acres	500
Harvesting 75 tons fruit per year	450
Total	£3,134

This is £121 per acre or £42 per ton of fruit

Costs estimated similarly for conventional plants and picking methods, yielding 4·5 tons per acre.

	£
Growing costs, 17 acres @ £91 per acre per year	1,547
Harvesting 75 tons fruit per year @ £40	3,000
Total	£4,547

This is £267 per acre or £60 per ton of fruit

These figures are based on estimates of work and machine performance derived from limited experience with prototype machines; they assume high yields for both methods of growing; they assume that growing costs, except for pruning, are the same for both methods of growing, which may prove not to be true; and they assume a machine and plantation life which has yet to be proved. They must, therefore, be treated with reserve. Also, they do not include general overheads, so do not represent the full cost of production by either method, although they are comparable.

Discussion

Machine picking of black currants offers a means of reducing production costs to enable the crop to be grown at a reasonable level of profit, provided high yields can be obtained. Should the fixed picking head, either in a static or a mobile machine become generally used, an entirely different method of growing will have to be adopted. This raises problems of establishment, spacing, pruning, nutrition, weed control and pest and disease control, which still have to be solved. A likely method is closely spaced bushes, established from direct planted cuttings, grown in beds. A plantation will crop only in alternate years as the bushes will be cut to the ground at picking time. This may eliminate pruning as a separate operation. Herbicides and fertilizers, except for nitrogen, might be applied by conventional means in alternate years

immediately after harvesting. Pesticides and nitrogen might be applied by overhead boom sprayers as necessary. Ideally, harvesting will be completely mechanized, the machine including a cutter, elevator, picker and branch shredder, so that only the picked fruit will be carried from the plantation. Evolution of such a method, should it be possible, will take a number of years, but the programme of work necessary for it is well under way.

SUMMER AND AUTUMN CAULIFLOWER

P. J. Salter, *National Vegetable Research Station*

With the introduction of varieties of Flora Blanca and Australian types of autumn cauliflower into this country, it is now possible to produce higher quality heads throughout the autumn months than was possible with most of the varieties of the Italian type. The problem is to maintain a continuous and even supply of cauliflowers throughout the summer and autumn months after the early summer crop has ended. The same, or different varieties of cauliflowers, may be sown in succession at weekly intervals from March until June, so ensuring a supply of heads from July until December, but weather conditions, as the curds develop, so affect the rate of maturity of this crop that peaks of production still occur. Not all growers wish to sow as frequently as this and would prefer to sow as few times as possible commensurate with obtaining a continuous supply of heads. In such circumstances it may be possible to obtain a successional supply of heads by sowing, on a small number of occasions, seed of varieties which require different periods of time to reach maturity. This was demonstrated in a trial at Efford in 1962 with Italian, Flora Blanca and Australian types of cauliflower sown on only two occasions, 26 April and 25 May, and from which two plantings from each sowing date were made. This resulted in a cutting period for the Flora Blanca type which extended from 14 August to 5 November while that of the Australian type was from 17 September to 3 December. Experiments were therefore started in 1963 at the National Vegetable Research Station, and at various Experimental Horticulture Stations and Kirton Experimental Husbandry Farm, to determine the best cultural methods of obtaining a continuous, even, supply of good quality heads from July until December and to study the factors which influence the growth and development of cauliflower plants.

In the first year of the experiment, the performances of varieties of All-the-Year-Round, Australian, Flora Blanca and Italian types were compared. Seed was sown at each centre on 25 March, 19 April, 10 and 26 May, and 10 and 20 June, these dates being chosen to give time for approximately equal numbers of day-degrees above 42°F to accumulate between each sowing. The plants were raised in unheated frames and were planted in the field 6–7 weeks after sowing. Irrigation was given frequently in the frames, and when possible in the field, to maintain satisfactory growth.

At Wellesbourne it was found that, sowing a representative variety of each of the All-the-Year-Round, Australian and Flora Blanca types on each of the six dates, enabled marketable heads to be cut from the end of July until the middle of December without any discontinuity in the supply of heads from any of the three varieties used, but the number cut per week fluctuated widely. Only the All-the-Year-Round type produced a consistently uniform curd of good quality from all sowings and could therefore be used throughout

the season; it required the shortest time from sowing to maturity of all the types grown. This type, however, did not produce the highest quality curds from September onwards and other types were preferred for this cutting period. Plants of the Flora Blanca type, sown in March and April, tended to produce a proportion of poor quality, bracted and ricey curds at Wellesbourne and the results support the advice of the seedsmen not to sow varieties of this type before 10 May. To obtain a continuous supply of the highest quality curds it was found that the All-the-Year-Round type was best for the early sowings, maturing in July and August, but Australian and Flora Blanca varieties gave bigger heads of higher quality than the All-the-Year-Round type from the later sowings. Varieties of the Italian type were much inferior to those of the other types.

Results obtained at the other centres in 1963 were in general agreement with those reported above but differences in the performances of the various types occurred because of the different weather conditions experienced at each centre. For example at Rosewarne, plants of All-the-Year-Round and Flora Blanca types from the same sowings matured at the same time, whereas at other centres the Flora Blanca type matured significantly later than All-the-Year-Round. The performance of the Flora Blanca varieties, grown for the first time at Rosewarne, and also of the Australian varieties, was disappointing at this centre. At Stockbridge House and Kirton there were marked peaks of production of the All-the-Year-Round type at the beginning of August, when cutting from the first two sowings was taking place simultaneously, and in early October, when plants from the last three sowings were being cut at the same time. In both instances the peaks of production with this variety were associated with periods of warm weather. Flora Blanca and Australian types did not appear to be so responsive to warm weather during the cutting period and they provided a more uniform supply of heads from the end of July until early December at all centres. With the weather prevailing in 1963, the sixth sowing made on 20 June was too late at several centres to allow many of the plants to mature heads before adverse conditions set in.

These first year's results suggest that the timing of successional sowings, on an accumulated temperature basis, might provide a means of taking into account variable weather conditions within the sowing period from March to June, one of the factors contributing to the uneven supply of cauliflowers for market. Although continuity of supply was maintained from six sowings, there were still considerable fluctuations in the number of crates cut per week, especially with the All-the-Year-Round type of cauliflower, arising from the weather conditions prevailing when the curds were maturing. This effect can be overcome to some extent by the use of Australian and Flora Blanca types for later sowings.

In 1964 continuity of supply during the difficult months of July and August was achieved by making the first sowing of the All-the-Year-Round type, and the early summer variety Delta, on 19 March in the unheated frames. The second sowing of All-the-Year-Round, and other types, was made on 23 April at Wellesbourne (142 day-degrees above 42°F after the first sowing). Cutting started at the beginning of July from the earliest sowings, following on from the early summer crop, and continued until cutting started of plants from the second sowing. The earliest maturing plants of Delta buttoned, but the later maturing plants produced high quality curds of a good size.

Although the timing of the six sowings made in 1964 was based on accumulated heat units, and different numbers of day-degrees above 42°F were used for each centre to take into account the local conditions, there were still big fluctuations in the number of heads cut per week. In order to determine the factors, both cultural and climatic, which affect the time of maturity in cauliflowers and hence to know whether this can be regulated to any extent, complementary studies on the development of the cauliflower plant in relation to cultural practices and environmental conditions have also been started at Wellesbourne. The experiments briefly outlined above will need to be repeated for several seasons before any recommendations can be made but it is hoped that results from this type of work, together with those from the more fundamental studies, should enable continuity of production to be planned on a firmer basis than the earlier empirical ones used at present.

Direct drilling of this crop is another possible cultural development being currently studied at Efford and Luddington. An observation study at Efford in 1963 compared the effect of direct drilling of two varieties of autumn cauliflower with that of the traditional transplanting method. The results of this first year's study indicated that, to be able to harvest the crop over the same period as a transplanted crop and maintain yields, the direct drilling of cauliflower should take place, under the conditions experienced at Efford, approximately three weeks later than the seed would normally be drilled for transplanting. At Luddington in 1963 a similar comparison was made between direct drilling and transplanting, but on three successive sowing dates. Again two varieties were grown and, in addition, three different planting dates were used from each seedbed to compare the effect of age of transplant on subsequent performance. The results showed that from the same, or similar sowing dates, the differences in median harvest date between direct drilled plants and those transplanted when 5–6 weeks old was never more than 14 days, the direct drilled plants being the earlier. In both varieities the earliest sowing gave the highest yield and the direct drilled crop gave a slightly higher yield than the earliest transplanted crop. When plants from the same seedbed were planted out at a later stage, the yield was severely reduced and the plants were progressively later in maturing. Similar results on the effect of age of transplant on subsequent yield and time of maturity have been found at Wellesbourne. Further work is being carried out along the above lines and possible cultural problems associated with direct drilling such as weed control are being examined. The advantages and disadvantages of direct drilling over transplanting will need to be carefully appraised before recommendations can be made, but the method appears to have distinct possibilities for reducing labour costs for this and other crops.

Short Notes on other Experimental Work

MANURIAL REFERENCE PLOTS

One of the earliest long term trials to be laid down on many of the Experimental Husbandry Farms was the manurial reference plots. Their immediate aim was to obtain information on nutrient deficiences and likely responses to fertilizers which would be of assistance to Directors in establishing a sound manurial policy on the Farm. This was, of course, only a short-term objective and the plots have other wider uses which has justified their continuation.

Reference plots are simple unreplicated experiments testing nitrogen, phosphate and potash each at two rates, of which the lower is usually 'nil', in all combinations on a range of crops grown in rotation. At the five farms where these plots have been in existence for some years, six course rotations were used and there were six blocks of plots, so that all the crops in the rotation were represented each year. This enables an assessment of the effects of weather and other seasonal factors on yields and responses to fertilizers to be made. In addition to the eight plots per block required to test the fertilizer combinations already described, there were in each case two extra ones receiving farmyard manure, either annually or for appropriate crops, alone and in combination with a balanced fertilizer dressing.

As well as providing immediate information on manuring the plots are likely, over the years, to give data on the availability and rate of release of soil reserves of nutrients, especially phosphate and potash. In most cases deficiencies of one or more of the major nutrients soon appeared and severely limited cropping on some plots. Here the plots can provide useful material for the demonstration of deficiency symptoms and also for analysis to help in establishing or confirming critical levels in plants and soil. Such information, while its practical significance may not be immediately obvious, is of great value to advisers for whom it may be the only reliable source of such information.

Over the years the plots, with their known history, become increasingly valuable as sources of soil for analytical and other investigations. An example of this is their use in the recent comparisons of extractants for the determination of available phosphorus and potassium, which has led to the adoption of a standard method throughout the N.A.A.S. Samples are in frequent demand by research stations for fundamental work on the soil.

In the early years of these experiments yields have generally been taken and it is hoped to present shortly a summary of the main findings. In future the layout on many of the Farms will be simplified and in most cases the whole groups of blocks will be cropped uniformly each year. This will maintain the plots while reducing appreciably the cost and effort of carrying them on and will enable, where required, *ad hoc* investigations, such as the comparison of different varieties of the same crop or the growing of new crops about which information is required, to be superimposed on the existing plots.

These experiments have often been criticized as being of little practical value, especially because many of them are at deficiency levels, but they can provide material for research and sites for special investigations which may be invaluable in the future.

J. Webber

FEEDING MOIST BARLEY

It has been stated that barley, with more than 17 per cent moisture content, is a better feed for livestock than barley which has been dried down to 14–15 per cent for safe storage in bins or in heaps. The substance of this claim is that storage at this higher moisture content alters the character of the grain in two respects. Firstly, when moist barley is crushed the fibre of the grain is flattened and preserved intact rather than broken up into fragments or dust. The processed barley is therefore more palatable because it is free from dust and there is less risk that fine particles of meal will coalesce, to form indigestible lumps in the stomach, leading to digestive disorders, or create a dust laden atmosphere conducive to respiratory troubles. This improvement in texture is purely physical or mechanical in nature and it can be assumed that the same advantages would be realized if barley, dried to 14–15 per cent, was re-wetted to 17–18 per cent, which appears to be the optimum level for processing.

Quite another matter is the change in the character of the grain brought about by the fermentation which occurs under conditions of sealed storage. The extent of the change appears to vary with the moisture content. Barley at 18 per cent moisture comes out of store in a condition indistinguishable from grain stored normally at that moisture content, for example in sacks. At 22 per cent a slightly 'malthouse' or mildly acidic odour indicates a limited degree of fermentation, whereas at 26 per cent the smell is quite pronounced and the berries are slightly darker and less bright than usual barley. However, even at this high moisture content, only small quantities of the breakdown products of fermentation can be detected by analysis: for example at Gleadthorpe in 1962, the alcohol content of barley stored at 26 per cent moisture varied from 0·05 to 0·62 per cent, an insignificant proportion. Laboratory analysis, in fact, does not suggest that grain withdrawn from air-tight silos differs appreciably in nutrient content from normal grain. The real query is whether the digestibility of the nutrients is improved by the process of fermentation and, if so, whether the improvement in utilization is enough to balance the losses of total nutrients which must occur when grain ferments. This question is not an easy one to answer. At least it can be said that moist grain, which has undergone some fermentation, has proved to be a perfectly satisfactory food for stock.

Feeding Beef Cattle and Poultry at Gleadthorpe E.H.F.

During 1962–63 barley rolled at 26 per cent moisture content was fed to yearling steers at up to 16 lb per head per day and this diet, supplemented by 45 lb silage, produced good growth and liveweight gains. Also in this season a poultry mash, containing 60 per cent of 18 per cent moisture barley, was fed to laying hens on deep litter with excellent results. The moist barley mash appeared to be more palatable than the same formulation based on dry grain and it was noticeable that it ran less freely in the tube feeders and thus waste by spillage from the feeder trays was less.

In 1963–64 more precise information was obtained in an experiment with fattening cattle finished out of yards in late spring. Yearling Friesian steers summered at grass, were yarded in three balanced groups, and after a three week introductory period to accustom them to high levels of barley feeding, rolled barley at moisture contents of either 15 per cent, 22 per cent or 26 per

cent was fed *ad lib* with 22 lb silage per head per day. However, after barley intoxication had occurred in two of the yards, and one bullock had died, this regime was modified and the barley was fed twice daily to appetite. All but three of the bullocks were slaughtered in mid-April.

The average daily intake per head of barley dry matter was 13·1, 15·2 and 15·7 lb for the 15, 22 and 26 per cent moisture content barleys respectively. The larger intake of dry matter by the cattle fed on moist grain was clearly associated with greater palatability. It was evident from the amount of grain left in the mangers that the bullocks cleared up the moist barley more readily at night than the dry barley. As might be expected, from the increased intake, better liveweight gains were recorded in both groups receiving moist barley and the condition and bloom of the cattle in these groups was noticeably superior to that of the 'dry barley' cattle. Up to a month before slaughter the better performance of the moist barley bullocks more than accounted for the greater consumption of dry matter and, in terms of dry matter consumed per pound of liveweight gain, the moist barley converted slightly more efficiently into meat. At slaughter the differences in this respect between the groups had lessened because the dry barley group, being less forward, made up some of the leeway: several of the moist barley cattle were rather overfit at disposal because they were retained beyond their time for purposes of demonstration. These results were obtained with *ad lib* feeding, a system which possibly exaggerates the good effect on performance of a more palatable food and makes it difficult to assess any differences in feeding value. Next year the aim will be to maintain the same level of dry matter intake for the three groups on low, medium and high moisture content barley reactions respectively. The barley part of the ration will be supplemented by a rather more generous allowance of silage than was the case last year.

In 1963–64, 26 per cent moisture barley also provided the cereal part of typical 'barley beef' rations for intensively fed cattle with very satisfactory results; 22 per cent barley was included in poultry laying mash up to about 30 per cent.

Feeding Beef Cattle and Pigs at Boxworth

Two sealed silos were filled with moist barley during the 1963 harvest. One was filled over a period of five days, with barley at about 18 per cent moisture and the other over three days with barley at about 24 per cent moisture. Grain from both silos has been used in rations fed to dairy cows and fattening cattle, with no apparent ill effects.

To obtain more detailed information on the value of moist barley a small feeding trial was started on 12 May, 1964. Two groups of six January born calves were started on intensive fattening rations, containing barley at either 18 or 24 per cent moisture. The proportion of barley was varied in each ration to allow for the different moisture contents.

Grain at 18 and 24 per cent moisture rolled easily and the cattle took readily to both rations. During the summer, when most of the grain at 24 per cent moisture had been removed from the silo, the remaining grain showed considerable surface mould. After augering from the silo the grain appeared normal but when rolled and mixed it heated very rapidly. In spite of this heating and musty smell the ration was still eaten by the cattle.

From 12 May to 22 October, 1964, both groups of cattle fed barley made satisfactory liveweight gains. The group receiving 18 per cent barley gained and average of 2·61 lb per day compared with 2·44 lb for the group on 24 per cent moisture barley. During this period the cattle receiving 18 per cent barley consumed more food in terms of dry matter than the group on 24 per cent barley but were the more efficient converters of dry matter into liveweight gain. This trial is still in progress and will be repeated with larger groups of cattle using barley harvested in 1964.

Comparisons have been made with rations containing 40 per cent of ground barley fed to pork pigs. One ration contained barley stored at 14 per cent moisture and the other contained barley taken from a sealed silo at 18 per cent moisture. The rations were fed *ad lib* from self feeders to groups of about 20 pigs starting at 9–12 weeks of age up to 19 weeks when they were slaughtered and graded.

Results from feeding the two rations were practically identical in terms of food conversion and liveweight gain. The food conversion ratio for the first batch of 44 pigs was 3·2 and for the second batch of 40 pigs it was 3·3.

There was a difference in grading results which favoured the groups fed on barley at 14 per cent moisture, and the average price per pig was £11 8*s.* 5*d.* The groups fed on barley at 18 per cent moisture had 10 per cent more grade 'B' carcasses with an average price of £11 7*s.* 0*d.* per pig.

P. N. Harvey

GRASSLAND RECORDING AT BRIDGET'S AND BOXWORTH

Although grass has always been the most important single crop grown at Bridget's and Boxworth, it is only recently that an attempt has been made to measure its level of output and assess the relative merits of various types of forage. This has been achieved by grassland recording which has been carried out at Bridget's in 1962, 1963 and 1964 and at Boxworth in 1963 and 1964. Recording has been over the total grass acreage and comparisons made in terms of Utilized Starch Equivalent (U.S.E.), except at Bridget's in 1964, when only sample fields were recorded and results converted to Cow Grazing Days (C.G.D.). Both farms are intensively stocked and at each the grass is utilized by a dairy herd and a ewe flock producing fat lamb.

Average production at Bridget's for 1962 and at both farms for 1963 was 20 cwt of U.S.E. per acre. Figures up to October, 1964, would indicate a higher average in this season, due to the earlier spring, and an increase in the acreage which has been conserved. These results are well above the national average of 13 cwt U.S.E. per acre.

At Bridget's, the majority of grass comes from 3–4 year leys and of these no difference has been detected between Cockle Park and timothy/meadow fescue types. Production has been 21–22 cwt U.S.E. per acre, 70 per cent of which has been utilized in May, June and July. Various other mixtures have been compared in replicated five acre padocks but all of them have been disappointing in their first two years when compared with timothy/meadow fescue. Tall fescue/timothy has failed to extend the grazing season and S.23 ryegrass and S.37 cocksfoot have given poor utilized production in the dry late-summer of 1964.

At Boxworth, leys are of various mixtures, some being left down considerably longer than at Bridget's. Age of the ley appears to have had no effect on the utilized production.

On both farms lucerne/cocksfoot leys have consistently been the highest producers with yields of over 28 cwt U.S.E. per acre, but utilization problems keep the acreage down to 10 per cent of the total.

Italian ryegrass is grown on both farms to extend the grazing season and as a safeguard against a summer drought. At Bridget's, some is undersown under a cereal crop to provide an early bite the following spring and is then ploughed up for kale. The rest is maiden-sown to provide mid-summer grazing in the same year and is also ploughed and sown with kale after the following spring. In both cases, the total production from the early-bite ryegrass and the kale extends the grazing season at both ends and has exceeded 25 cwt U.S.E. per acre. It also allows the longer leys to be shut up for early cut hay and silage. The maiden sown Italian is not vernalized and therefore keeps growing through midsummer. Providing a good take is achieved, yields of 16 or 17 cwt U.S.E. can be reached and it can prove invaluable in a dry summer such as 1964. At Boxworth, it is maiden-sown in the spring and then ploughed in time to drill with winter wheat the following year.

There is no evidence on either farm to show that nitrogen manuring had any conclusive effect on utilized productions; nitrogen rates did not vary greatly from field to field, the average being 130 units per acre, so any differences in production were likely to be small and could have been masked by the effects of other management factors.

At Boxworth, there has been a distinct relationship between size of field and its utilized production per acre. Less production has been attained with the larger fields due to the effect of lower stocking rates and greater management difficulties. To rectify this, these fields have been split up into smaller units in 1964. At Bridget's paddock grazing is practised and all but the smallest fields are split into five acre paddocks.

It has been impossible to evaluate relatively subtle differences using Grassland Recording, but it has provided an interesting comparison between major types of forage. On an experimental farm, recording can also be a means of comparing the output of experimental paddocks. On a commercial farm, however, the larger amount of recording and calculation work would be out of all proportion to the information gained and the time would be better spent keeping other more useful records.

T. C. B. Horne

INVESTIGATIONS INTO NEW TECHNIQUES OF POTATO GROWING

During recent years chemical weedkillers have been introduced for use in the potato crop. Unlike the modern herbicides used in cereals, those at present available for potatoes are not selective but must be employed in a way which avoids damaging the potatoes. Apart from one technique, which is still at the experimental stage, this has so far meant that the herbicides must be applied before the potatoes have emerged or certainly before the emerging shoots have expanded their leaves. The present herbicides fall into two groups: contact and soil acting. In the former group are paraquat, diquat and dinoseb, though

dinoseb (used either as amine or as acid-in-oil) appears also to have some residual affect. Commercially available soil acting herbicides include simazine, a proprietary mixture of prometryne, simazine and linuron. Except for simazine these materials also have some effect on emerged seedlings.

Contact herbicides should obviously be applied to 'stale' land on which weeds have had time to germinate and application should be timed to coincide with the main flush of weed growth. If chitted potatoes of vigorous growing varieties have been planted they may emerge before the weeds have germinated, in which case the use of a material such as paraquat, which has no residual activity, would be inadvisable as many weeds would be likely to emerge unharmed after its application. (A technique of dribble-bar application designed to enable such materials to be applied inter-row after crop emergence is being tested by the manufacturers.)

Success with the soil-acting herbicides appears to vary with the state of the soil. A fine tilth, preferably in a moist condition, is desirable if the best results are to be obtained and even then relatively high volume rates (not less than 50 gallons per acre) are needed to distribute the chemical evenly.

Working mainly with commercially-available products, and making some selection of materials in the light of the relative emergence of weeds and potatoes and the likely occurrence of weeds which might not be controlled by certain products—in other words making a sensible choice from the available range—at Terrington E.H.F., a great difference has been found between the abilities of present materials to control annual weeds. None of these herbicides controls perennials, the tests have not included either grass weeds or wild oats. Plots on which herbicides have been used have normally been rather less clean than plots kept clean by cultivations but the reverse was the case in some trials in 1964. In an observation trial in 1961, and subsequently in fully replicated experiments, the yields obtained from King Edward potatoes sprayed with herbicides have been compared with those obtained from crops kept clean by cultivations and in each of the four years higher yields have resulted from the spray treatments. This suggests that cultivations in the growing crop were causing damage. In some cases, by modifying cleaning cultivations, higher yields than those resulting from the normal system of cultivations have been obtained and in 1963 (though not in 1964) as high as those obtained by doing no post-planting cultivations but relying on the spray. The latter treatment outyielded all other systems with the variety Pentland Crown in 1964. Arran Pilot gave higher yields when sprayed than when cultivated for weed control in 1963 but not in 1964.

Under conditions at Terrington it appears that an acceptable level of weed control, and usually an increased yield, can be obtained from the use of herbicides. The cost of the herbicides now on the market ranges from about 30*s.* 0*d.* to almost £5 per acre. At the lower figure it might be argued that herbicides would cost no more than inter-row cultivations but at the higher range of costs some gain in yield or other advantage is needed to justify this increased expenditure on an already expensive crop.

If herbicides are to be employed in potatoes, the ideal technique would be to build up a ridge of adequate size at planting and do no further cultivations until the crop is lifted. How high should the ridge be? Ridges of 4, 6 and 8 inches of soil cover over the setts have been tested at Terrington and, with

both King Edward and Majestic, it has been found that, although the plants emerge some two days earlier from low ridges, the final yield is lower and the proportion of green tubers higher than from ridges 6 or 8 inches high. The best yield of Majestics came from the highest ridges. On the silty loams of Terrington, provided healthy seed is used, there seems no reason why the final ridge should not be put up at the time of planting.

In 1964 Pentland Dell appeared less vigorous after growing up through 6 inches of soil cover than when ridges were harrowed down, but yield data suggests that even this variety prefers not to be disturbed by cultivations during the growing season.

During 1963 and 1964 the possibility of growing potatoes in flat topped beds 56 inches wide was examined. Each bed contained three rows of potatoes 14 inches apart. This method of growing has been found to be possible provided the whole bed can be lifted at one time as, for example, with a 2-row elevator digger. Yield results in 1963 with Majestic were good but there were considerably more green tubers in the beds than in adjacent 28 inch rows. The 1964 results for Majestic and King Edward seem likely to support those of the previous year and it is unlikely that there will be sufficiently persuasive data to justify advising farmers to adopt the bed technique for maincrop ware production.

F. E. Shotton

MINIMUM CULTIVATION FOR CEREALS

A few years ago a series of experiments on ploughing depths was carried out at some of the Experimental Husbandry Farms. The results suggested that seedbeds prepared by cultivation without using the plough at all gave yields of cereal crops similar to those obtained normally.

This observation raised doubts in many minds at the time as to the need for ploughing, especially as the principal object of ploughing is the control of weeds. However, many weeds are now controlled easily and efficiently by chemicals. Ploughing may help with drainage and the creation of better soil conditions for growing crops. It also helps to bury and distribute farmyard manure and artificial fertilizers through the soil. At present, traditional methods are felt by most people to be essential for the successful cultivation of cereals, but experimental evidence on this subject is rather scanty and conflicting. There is, for example, no reason to suppose that plants require their nutrients evenly distributed throughout the soil since grass (a type of cereal) grows for many years without any soil disturbance.

Pilot trials were undertaken at five E.H.F's last year to assess the potential of various machines for growing cereals under a minimum cultivation regime, to gain experience in the necessary techniques, and to expose any difficulties.

Two machines, uncommon in England, were tried alongside the typical equipment of arable farming. They were the sod seeder, fitted with special boots designed to place seed in a small furrow cut in the turf, originally developed in Australia for the renovation of old pasture, and the disker seeder, a single gang disc harrow fitted with a seed box, typical of the machines used on the prairie grain growing areas of Canada.

The following table gives brief details of the results obtained at each farm.

Yields of winter wheat as percentage of control at 85% D.M.

Farm and soil type	*Seeded after*	**Control* (*cwt/acre*)	*Sod seeder*	*Disker seeder*	*Rotavator and disc drill*	*Disc harrow and disc drill*
Boxworth (chalky boulder clay)	Stubble	29·0	84	98	88	—
Bridget's (clay with flints over chalk)	Ley	40·3	111	119	104	105
	Stubble	45·8	94	97	86	92
Gleadthorpe (sandy loam)	Ley	26·6	101	105	109	92
High Mowthorpe (chalky silty loam)	Ley	49·5	93	95	102	109
	Stubble	48·7	106	99	101	99
Rosemaund (sandy clay loam)	Stubble	32·4	86	87	98	97

*Control = Wheat grown in seed beds prepared by ploughing and harrowing.
Two other trials on spring barley at Bridget's and Boxworth using similar machines and techniques gave equally encouraging results.

During the course of the trials several problems arose which will have to be solved or avoided before the technique can truly be said to be a 'breakthrough' in cereal growing.

New types of drill coulter will have to be developed in order to ensure proper penetration of hard compact soils, and the successful deposition of seed and fertilizer far enough down in the soil. The problem of perennial grass weed control in the context of minimum cultivations may become very important. The husbandry of crops, their nutrient requirements, seedrates and so on, grown in this way may be vastly different from traditionally grown crops. The return of crop residues confined to the immediate top soil may have far reaching effects on soil texture, so much so that the possibility of creating a tilthy easy working loam on top of an intractable clay does not seem wildly beyond the realms of possibility. The results have proved sufficiently encouraging for a series of long term trials to be laid down in 1964, to study the validity of minimum cultivation as a means of improving the efficiency of cereal growing and to provide some information on nitrogen requirements under this system and whether or not it is possible to develop an upper horizon of easy working soil, rich in organic matter from accumulated crop residues.

J. E. Whybrew

SLURRY FOR GRASSLAND

Two factors have recently increased the need for information regarding the value of slurry on grassland. The first is the adoption of stock housing systems which require little or no bedding and which give rise to large amounts of slurry. The second is the section of the Rivers (Prevention of Pollution) Act 1961 which deals with the disposal of farm waste, particularly liquid manure and silage effluent. It is logical to assume that much slurry will in future be applied to grassland and that this slurry will have a certain fertilizer value.

In 1962 an experiment was started at Trawscoed to examine the nitrogen replacement value of undiluted cow slurry applied to grassland.

Three rates of application were used, 1,500, 3,000 and 6,000 gallons of slurry per acre.

The yields of hay and aftermath given by these dressings were compared with those produced by the equivalent amounts of inorganic nitrogen applied on the following day as sulphate of ammonia. Two times of application, March and April, were compared. In order to eliminate the effects of phosphate and potash from this experiment, a generous basal dressing of 120 units of P and 120 units of K was applied. Slurry was removed from under the slatted-floor cow yard by means of a vacuum tank. In order to ensure accurate distribution it was applied to the experimental plots by watering can. Samples were taken for chemical analysis and slurry used for the March application was found to contain ·38 per cent nitrogen on a wet matter basis. The amounts of inorganic nitrogen equivalent to 1,500, 3,000 and 6,000 gallons per acre of slurry were therefore contained in approximately $2\frac{1}{2}$, 5 and 10 cwt per acre of sulphate of ammonia respectively. The slurry applied in April contained ·44 per cent of nitrogen and the equivalent dressings of sulphate of ammonia were 3, 6, and 12 cwt per acre.

Yield of dry matter (cwt per acre)

Dressing per acre	*March application*			*April application*		
	1st cut	2nd cut	Total	1st cut	2nd cut	Total
Slurry						
Nil	30·6	13·5	44·0	28·8	13·8	42·6
1,500 gallons	38·1	12·9	51·0	41·2	12·3	53·4
3,000 gallons	43·9	12·8	56·6	37·7	13·5	51·2
6,000 gallons	45·5	13·5	60·0	43·6	14·4	58·0
Sulphate of ammonia						
1,500 gallons slurry, equivalent N	43·6	9·8	53·2	39·6	10·8	50·4
3,000 gallons slurry, equivalent N	47·5	11·7	59·1	46·4	13·5	59·9
6,000 gallons slurry, equivalent N	47·0	17·0	64·0	40·4	16·4	56·4

The total yields given by the March application of slurry were lower than the total yields from the equivalent rates of sulphate of ammonia. Following the April application slurry was superior except at the medium rate of dressing.

Aftermath yields following slurry were as good, or better, than those given by the corresponding inorganic nitrogen rate, except at the 6,000 gallon per acre level of application.

On average, over all rates and times of application, the nitrogen in the slurry was 82 per cent as efficient as the inorganic nitrogen.

One very noticeable effect on the sward was the suppression of white clover by high rates of sulphate of ammonia. March and April dressings appeared to depress the clover content equally. Increasing applications of

slurry also decreased the clover content of the sward but not to such a great extent as the sulphate of ammonia. At the highest rate of slurry there was almost complete ground cover. High rainfall followed both the applications and may have been an advantage in helping to disperse the layer of organic material. The high rate of application of sulphate of ammonia caused some scorching of grass leaves but this effect did not persist.

The investigation is being continued.

J. C. Wilcox

HIGH NITROGEN RATES FOR GRASSLAND

There is plenty of evidence to show the very marked response to nitrogen on grassland. It is generally assumed that higher levels of fertility require selected species and strains of grasses in order to make optimum use of high nitrogen rates. An experiment is in progress at Great House E.H.F. to determine the response to nitrogen on grassland at an altitude of 800 ft with a 60 in. rainfall. The investigation is taking place on two types of sward in the same field, the one a young ley and the other an old permanent grass sward. The ley, when established, was predominantly S.24 ryegrass, S.100 white clover with some timothy and meadow fescue, whilst the permanent grass at the commencement contained 40 per cent of good species such as perennial ryegrass, cocksfoot, meadow foxtail and wild white clover and 60 per cent of fine-leaved fescues, *Agrostis*, buttercup, plantain, daisy and other weed species.

Nitrogen is being applied in four equal dressings at rates of 200, 400, 600 and 800 units per acre. Phosphate and potash are applied to balance the nitrogen, phosphate at 100, 120, 170, 220 and 270 units per acre and potash at 160, 200, 300, 400 and 500 units per acre. Cuts are taken at approximately monthly intervals.

In two years the changes in the sward are very marked. In the ley, the no nitrogen plots were the only ones to retain an appreciable amount of clover. There was a little clover where 200 units were applied but beyond this it was completely eliminated. In the permanent sward there was a marked and rapid change following the higher rates of nitrogen. Weeds (apart from broad leaved dock), fine leaved fescues and clovers disappeared quickly whilst perennial ryegrass became dominant.

Differences in response to nitrogen were apparent even in the first full harvest year of the ley. Where no nitrogen had been applied, the ley gave a higher dry matter yield than the permanent grass, presumably due to the superior nitrogen fixation of the S.100 type white clover, in contrast to the wild white clover in the permanent sward. At 200 units the yield of dry matter from both types of sward was equal, but with nitrogen dressings in excess of 200 units, the dry matter yield was higher from the permanent grass than from the ley. Neither sward yielded significantly more at 800 units nitrogen than at 600 units.

The seasonal pattern of growth was very similar in both swards but the permanent grass yielded a slightly higher proportion of its total dry matter yield in the first cut.

The experiment is being continued to ascertain the long term effects of high nitrogen dressings on both swards. An initial tiller count indicated that there were approximately twice as many leaf tillers in the permanent sward

as in the ley but this is changing. Density of the permanent grass sward is becoming less apparent, partly due to scorch resulting from heavy dressings of nitrogen and partly due to the elimination of bottom grasses.

As a corollary to this trial two levels of nitrogen, 40 units and 400 units, are being compared for fat lamb production. Two years results show that the swards dressed with 400 units are carrying twice as many lambs and that these lambs are growing faster.

C. H. Mudd

AUTOMATIC FEEDING OF CALVES

Automation of calf feeding could result in some saving in labour and, providing the cost of automation were not too high, a reduction in calf rearing costs. A machine* is now in use at Liscombe Experimental Husbandry Farm which has taken the first steps towards successful automation of milk-replacer feeding to calves in overcoming such problems as feed preservation, temperature regulation and control of voluntary liquid intake.

Feeds of between one and two pints are produced at regular intervals. The calves suck the mixture out of a dispenser bowl through a single rubber teat. The speed of working may vary between 8 and 17 feeds per hour (assuming each feed is taken as soon as it is prepared) depending mainly on the type of timer motor used (three are available). Most milk powders are suitable for use in the machine except those which froth excessively (e.g., dried skim milk powder) or those which have become lumpy or damp. The amount of water per feed can be varied quite simply. The amount of powder per feed cannot be varied. The amount dispensed is usually about $1\frac{1}{4}$ oz per feed.

From early observations, using the slowest timer motor, it was concluded that the maximum size of group which could be contemplated, if reasonable performance were to be maintained, was twelve calves. The data in the table below was obtained from a group of twelve Devon × Friesian steers reared outside. The machine, working at 10–12 feeds per hour, was housed in a corrugated iron shelter and the calves had free access to good quality herbage and early weaning concentrate. Health was good and liveweight gains were comparable to those of a similar bucket fed group, although the nutritive value of the powder used in the machine was the lower.

Mean liveweight performance (summer 1963)

Treatment	*Initial*		*Weaning*			*Post weaning*		
	Age (days)	Wt. (lb)	Age (days)	Wt. (lb)	L.W.G. (lb/hd/day)	Age (days)	Wt. (lb)	L.W.G. (lb/hd/day)
Bucket feeding	9	100	52	151	1·19	81	107	1·87
Automatic feeding	7	106	51	151	1·07	83	207	1·73

*Nurs-Ette, K. & K. Manufacturing Inc., Minneapolis 15, Minnesota, U.S.A.

Mean food consumption (summer 1963 for 21 days prior to weaning)

Treatment	*Concentrate* (lb)	(lb/day)	*Milk powder* (lb)	(lb/day)
Bucket feeding	38·4	1·8	19·3	0·9
Automatic feeding	21·6	1·0	28·7	1·4

Liveweight gains for both groups before and after weaning were similar. The higher milk powder consumption of the automatically fed calves increased the cost of their diet slightly.

Several groups of up to nineteen calves have been reared using the quickest timer motor. A 'put and take' system was used, i.e., as soon as some calves were fit to wean, they were taken out of the group and younger ones introduced. The young calves were taught to feed for two days and then competed successfully with the older ones for the teat. Performance, using this system, was quite satisfactory. Average food consumptions are given below.

Mean food consumption from arrival until weaning (spring 1964)

Concentrate (lb)	(lb/day)	*Milk powder* (lb)	(lb/day)	*Hay* (lb)	(lb/day)
11·7	0·4	47·1	1·7	4·7	0·2

There was one death due to *Escherichia coli* septicaemia. After this, on veterinary advice, an antibiotic was mixed with the milk powder. The performance of most of the other calves was satisfactory but some difficulty was experienced in getting them used to eating concentrate and hay. This seems to indicate that the machine should be adequately stocked whenever possible.

About 200 calves have so far been reared successfully at Liscombe using automatic milk replacer feeding. No serious difficulties have been encountered. There has been some nutritional scouring in the early stages but in general performance and health have been satisfactory. The machine appears to be fairly reliable although some components need regular replacement, e.g., rubber teats. In view of the high prices of these machines it is important that the greatest possible output be obtained from them concurrent with a high standard of stockmanship and good disease prevention precautions.

G. P. F. Lane

RESIDUAL EFFECTS ON PASTURE IN SUMMER OF HOUSING SHEEP IN WINTER

At Drayton and Rosemaund E.H.F's, in the course of an investigation into various aspects of wintering of sheep, a proportion of the ewe flock are housed during the winter. Although the ability to keep ewes indoors in a healthy condition has been demonstrated, no financial advantage from so doing has

been achieved. It was initially thought that increased productivity in the following summer from grassland not winter grazed would help to justify the expense of inwintering, but to date such an increase has not been conclusively demonstrated.

At Drayton, in the winter of 1961–62, replicated plots were winter grazed by 3 or 4½ ewes per acre, or not winter grazed, from mid-December until the end of March. During this period the grazing ewes were fed hay *ad lib* and steamed up, on a home-mixed ration, for six weeks before lambing in mid-March.

During the subsequent summer all plots were grazed at the rate of 3 ewes and their lambs per acre except one of the saved plots which carried 4½ ewes and their lambs per acre. Total lamb liveweight gain per acre was identical on all plots stocked at the same rate in summer regardless of their winter treatment.

In 1962–63 and 1963–64, the trial commenced in October, when all plots were stocked at either 3 or 4 ewes per acre and lasted until lambs were weaned the following July. Sheep were removed from the saved plots between mid-December and March and a different team of ewes with lambs grazed the whole trial from April onwards, to eliminate carryover effects on the stock from the winter period.

In both seasons total lamb liveweight gain per acre showed only marginal advantages for winter saving. In all three seasons there was a slight, but nevertheless consistent, trend in the individual lamb liveweight gain per day figures in favour of winter saved plots.

In 1963, although saved plots at Drayton looked greener in spring, the yields from a small area of each plot fenced off and allowed to grow on for hay were all practically identical. In the same season, at Rosemaund, following winter saving or winter grazing at two and four ewes per acre on permanent pasture from late November to late February, the field was shut up for hay. Virtually no differences in the haycrop harvested from the different treatments were recorded. A factor contributing to the lack of response at both farms that year was the severe winter weather and frozen ground which prevented normal grazing and treading of the pasture for a considerable time.

In 1963–64 Rosemaund repeated the experiment on both permanent pasture and ley. In milder conditions, the sheep were able to graze for the whole of the winter period without supplementary roughage feeding and both types of pasture subsequently showed a positive response to winter saving of the order of 4 cwt hay per acre, a 10 per cent increase in the hay crop following winter saving.

At Drayton in 1964, as well as the evaluation in term of liveweight gain, caged areas were set up on half the plots and were sampled fortnightly from the beginning of May to early June. The results of this sampling indicated that there was more grass available on winter saved plots early in the season but that, by hay time, this difference had disappeared. This confirms the previous year's visual observations and suggests an explanation of the tendency of lambs to do slightly better on winter saved land which may not always produce superior haycrops.

Increases in productivity, following winter saving of pasture as opposed to winter grazing, whether measured in terms of fat lamb performance or hay

yields, have in all cases except one been small. Indications are that the response to winter saving may be an earlier pasture growth in spring rather than greater total seasonal production.

D. A. Perks
F. J. Round

HEIFERS FOR BARLEY BEEF

The view is generally held that the barley beef system of producing beef is only applicable to steers. This arises from fear that heifers might become too fat for the present trade in beef.

However, the payments under the Livestock Guarantee System are payable for heifers at 365 lb carcass weight, providing they are Grade I and at 390 lb if they are likely to be Grade II. These weights are respectively 65 and 60 lb lighter than those applicable to steers. If heifers have a growth potential similar to steers, it is possible that they could come for slaughter six to eight weeks earlier than steers.

This lowered age at slaughter would have an important bearing on the profitability of fattening heifers for the following reasons: younger cattle have a better food conversion rate; if it is planned to market at peak prices in May and June, it would be possible to buy calves at the less costly period of July and August.

In order to test this line of thought, twelve Hereford × Friesian heifers were fattened at Trawscoed in 1963. The average weight of the calves at purchase was 115 lb and their average cost was £13 3*s*. 2*d*.

After weaning at twelve weeks of age, they were fed on a ration containing 17½ cwt of hammer-milled barley and 2½ cwt of protein. Both this mixture and hay were fed on *ad lib* offer. Rarely did the consumption of hay exceed 1 lb daily. The heifers were housed in a straw bedded pen at 18 sq. ft per beast. They fattened readily and there was a minimum trouble from 'bulling'.

The average age at slaughter was 306 days, with a variation of 72 days between the youngest and oldest. Generally speaking, it was the stronger-boned heifers which reached slaughter weight earliest. The average carcass weight was 420 lb against a live weight on farm of 760 lb. The killing-out percentage varied from 51·3 to 60·4 with a mean of 55·3. This illustrates the practical difficulty of producing a minimum weight animal with a certainty of its coming within the weight range eligible for the Livestock Guarantee Scheme. Ten of the heifers were graded I and there were two Grade II's. Even at 420 lb carcass, there was probably more fat than most consumers would like, and it was obvious that the heifers would have been too fat for present day demand if they had been kept to a greater weight.

The mean daily gain of the heifers from date of purchase to slaughter was 2·1 lb. This showed a variation from 1·9 to 2·3 lb. During the fattening period on the barley ration, the mean daily gain was 2·4 lb and the conversion rate was 5·02 to 1. This compares quite favourably with a group of steers of the same cross, fed in a similar manner in the previous season, when a daily gain of 2·5 lb was obtained with a conversion rate of 5·4 to 1.

These results do give some weight to the two points posed earlier. The gross margin, over cost of calf and food, left by the heifers was £14. This compares with a gross margin, in the previous year with the steers, of £16 6*s*. 4*d*. when

slaughtered at 875 lb live weight. When these steers were costed at the food prices used for the heifers, the margin was reduced to £14 14*s*. 8*d*. With heifers, capital was in use for a shorter period and to a lesser amount and it is clear, in this case, that feeding heifers intensively on the barley system was economically as effective as feeding steers.

W. M. R. Evans

DIRECT DRILLING OF VEGETABLES

Many vegetable crops, which used to be transplanted from a seedbed, are now being drilled directly on the site from which they are to be harvested. This practice has been brought about by labour shortages or the heavy labour costs of transplanting. In trials it has been found, in many cases, that the undisturbed direct drilled crops give heavier yields and mature earlier than transplanted crops. This may be especially the case if adverse weather conditions are experienced at planting time. A direct drilled crop is, however, occupying the land for a longer period than a transplanted crop and intensively cropped holdings may not be able to follow the same rotations as before if this method of growing is adopted.

Direct drilling experiments on autumn cauliflowers and leeks have been carried out at Luddington for two years. With two varieties of cauliflowers, direct drilling gave higher yields, and plants matured one or two weeks earlier, than transplanted plants from the same sowing date. Three separate sowings, at fortnightly intervals, were made for each variety each year and a higher yield from direct drilling was obtained five times out of six for All-the-Year-Round and four times out of six for Flora Blanca. In a similar experiment with leeks, successive sowings from the end of February to mid April gave good yields for harvesting in September or November, and early May sowing was harvested in January. It was necessary to earth up the leeks in order to get a sufficient length of blanched stem.

If crops are drilled with an ordinary seed drill, heavy seed rates have to be used as few drills give a sufficiently regular spacing of seeds and there is a considerable wastage of plants and labour in thinning. Seed and thinning are quite expensive items and the next logical step is precision drilling. By means of special drills, of which several makes are obtainable, seeds can be placed singly at set spacings, thus cutting down the seed rate per acre and making the final thinning much easier. Precision drills require uniformly sized round seeds which are produced either by sieving, in the case of naturally round seeds, or pelleting for irregular shaped seed. Most brassica seed can now be bought as graded seed for precision drilling but there does not appear to be any standardization of size of seed required for the different makes of drills. Pelleted seeds of such crops as carrots, lettuce and beetroot can be obtained but are expensive and in limited quantity. Pelleted seed has not become popular and one disadvantage is the need for a moister soil to enable the pellet to absorb water, soften and break down in the soil before germination can take place. For a good stand of plants, following precision drilling, it is essential to have a good germination. As this can never reach one hundred per cent under field conditions, seeds must still be sown thicker than the final requirement and a small amount of thinning is likely to be needed. The drilling rate applied is about three to four times the final spacing.

Developments in Potato Growing

Above: A 56 in. wide 'bed' planted with 3 rows of potatoes and photographed just before emergence. The silt soil is free from serious clods and has capped lightly under rainfall and is in a condition which seems very suitable for successful herbicide spraying

Below: Majestic potatoes on 9 June 1964; part of a study on seed size and plant population. The crop was sprayed with dinoseb acid in oil ($2\frac{1}{2}$ lb a.i./acre) at emergence and can be seen to be virtually weed free

PLATE I

Planting of Bulbs in Plastic Nets

Operator on left loading bulbs through the sleeve which holds the net. He places them in holes in the wooden jig. Second operator puts the plastic clips between the bulbs

Close up of completed net with specimens of plastic clips

Wooden sleeve holding the net. The cone on the left is an adapted tractor p.t.o. guard which aids in loading the net

PLATE II

Wick Watering of Mushrooms

Above: Arrangement of wicks on the bed

Below: Water supply to wicks from a plastic tube below the beds. Overflow via rubber hose on right

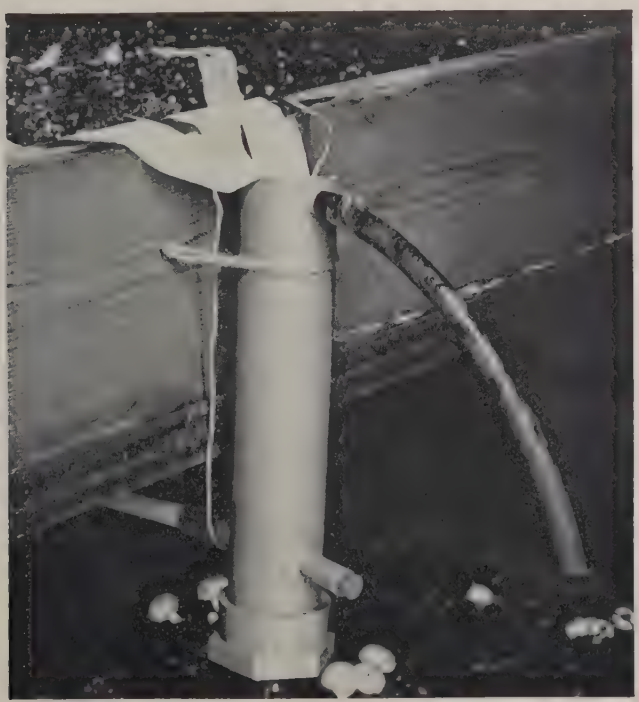


PLATE III

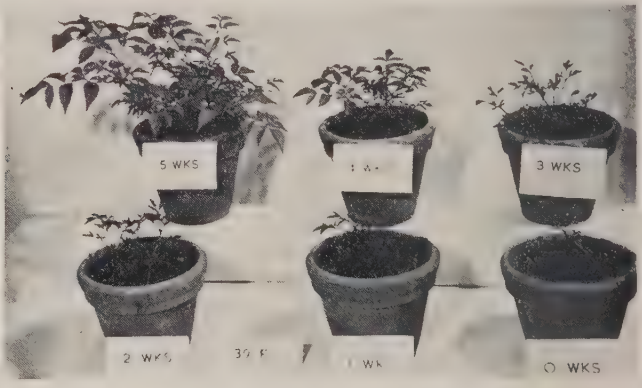
ROSEWARNE EXPERIMENTAL HORTICULTURE STATION

Marketing Narcissus as Buds

The flowers in the top row were picked at the following stages: *left to right*, sheath intact, sheath just burst, tight gooseneck, fat gooseneck. The lower row of blooms (just picked) illustrates these stages

STOCKBRIDGE HOUSE EXPERIMENTAL HORTICULTURE STATION

Dormancy Breaking in Astilbes



The plants have been given treatment at 39°F for the periods stated before bringing into the warm glasshouse

FAIRFIELD EXPERIMENTAL HORTICULTURE STATION

Experiments with Carnations

Illustrates experiment with different dates of planting of carnations and different plant spacings

PLATE IV

Pelleted seed of carrots, lettuce and beetroot have been examined at Luddington and laboratory germination has been recorded, together with the percentage of pellets containing seeds and the number of seeds per gramme weight. The findings from this examination are given in the following table and show that some samples were unsatisfactory:

	(1) *Lettuce*	(2) *Lettuce*	(3) *Carrot*	(4) *Rubbed Beetroot*
No. seeds per gram	83	19	117	37
Percentage pellets with seeds %	90	99	95	100
Laboratory germination (%)	23	82	81	35

Water was absorbed very rapidly under laboratory conditions and the pellets quickly disintegrated. Under field conditions the seed with poor germination gave very patchy stands. Graded spring cabbage seed gave 86 per cent germination in the laboratory and had 238 seeds per gramme compared with 338 for ungraded seed.

Trials of precision drilling cannot be isolated from work on crop spacing and weed control and all these aspects of growing are being, and will be, studied at the N.V.R.S. and the Experimental Horticulture Stations to provide more information on the economics and management of these new methods of growing.

Jean M. Garthwaite

MINIMIZING LOSS FROM TOMATO MOSAIC VIRUS

The symptoms of mosaic disease, caused by strains of tobacco mosaic virus (TMV), are well known to tomato growers. Since it is the most infectious and persistent plant virus known, the disease is very difficult to control. Work done at research and experimental horticulture stations over the past few years has added greatly to our knowledge of the disease, and discredited some of the misconceptions which were previously widely held. Experiments at Efford, in co-operation with Dr. L. Broadbent of the Glasshouse Crops Research Institute, have shown that infected plants suffer a yield reduction of about 15 per cent, in addition to losses from fruit quality defects. It has been estimated that the total value of these losses in Great Britain and the Channel Islands is about £3 million annually.

What can a grower do to reduce the risk of TMV attack? His aim should be to grow a healthy plant by taking precuations against infection at every stage of cultivation, and if the disease does appear, to try to minimize its effects by cultural means.

Control Measures

Use of virus-free seed

Although virus is not carried in the embryo, it can be carried in the seed coat, and sometimes in the endosperm. Seed treated against virus should be used. If not treated by the supplier seed can be soaked, for instance, in a 10 per cent solution of tri-sodium ortho-phosphate (TSP) for 20 minutes.

The smaller the seedlings are at pricking out time, the less will be the risk of root infection resulting from contact with contaminated seeds. Particular care must be taken when handling plants during grafting operations.

Cleaning glasshouses, equipment and clothing

The customary washing down of glasshouses between tomato crops reduces the risk of infection from dry diseased leaf debris remaining adhered to timber and glass. At Efford a standard solution of 1 part of formaldehyde in 49 parts of water is used for washing down.

It is best to steam sterilize tools and picking baskets between crops, but if this cannot be done they should be dipped in a 3 per cent solution of TSP.

The virus will persist for a year on clothing, even in daylight. Therefore clothes worn during one season should not be used the following season unless they have been dry-cleaned or washed in hot water using a detergent.

Treatment of the soil

One of the most damaging sources of virus is infected plant material remaining in the soil after a crop is cleared. Chemical sterilants at normal strength do little or nothing to control this. Indeed, their effect on soil micro-organisms may prolong the persistence of this plant debris, resulting in *increased* infection through the roots of the new crop. Disease symptoms will usually show in the tops of young plants about ten weeks after root infection.

Steam is the only effective treatment for sterilizing propagating composts and glasshouse soil, and a temperature of 200°F must be maintained for ten minutes.

Precautions during Growth

Visits to the nursery by persons not employed on the staff should be reduced to a minimum; and when visitors enter a tomato house they should wear an overall, kept in the house, to prevent their brushing the plants with their own clothing which might be infected. If visitors are to handle plants they should first disinfect their hands with TSP solution. Birds should be excluded from tomato houses.

Where a close watch for TMV symptoms reveals infected plants, these should be marked, together with ten plants on either side of them in the row. These plants should be trimmed and twisted last, after which knives and hands should be thoroughly disinfected. It is preferable for workers in infected houses not to enter houses free from TMV, but if this is necessary they should wash their hair and change their clothes first if further spread is to be avoided.

Since infected plants frequently wilt in bright sunshine, and loss in yield is due mainly to a failure of the flowers to set fruit, frequent overhead damping is recommended. While there is no experimental proof of its value, experience suggests that dry set can be reduced by this means. Damping may also partly compensate for the significant reduction in roots resulting from TMV infection by permitting the absorption of water through the foliage.

Tentative Treatments

Some Isle of Wight growers have kept plants free from TMV by growing them in loamless compost, separated from infected soil below by polythene sheeting. This method is not widely used, mainly because problems can arise when it is employed on a large scale.

Experiments at Efford have shown that the number of fruits with severe quality defects was reduced to half following early infection (i.e., when the first truss was in flower) compared to infection when the fifth truss was flowering.

Similar but even more pronounced effects also occurred at G.C.R.I. Therefore it has been suggested that a grower might deliberately infect his plants before the first flowers appear, but only if he has suffered consistently from quality defects. Deliberate infection with a mild strain of TMV to protect plants from later attack by a severe strain has not been tried because a sufficiently mild tomato strain has not been found.

Future Trends

The brightest hope for the future seems to lie in the development of tomato varieties which are tolerant of, or resistant to, TMV attack. There are indications that their introduction may not be long delayed. But virus still remains what is probably the tomato grower's greatest single problem, and even with resistant varieties continual vigilance will still be required to maintain disease-free crops. There is always the possibility that the appearance of new virus strains might result in damage more severe than that we are familiar with at present.

D. R. Smith

CO_2 ENRICHMENT FOR TOMATOES

Following upon the successful application of CO_2 enrichment to lettuce grown in heated glasshouses during the autumn to spring period, attention has been paid to the possibility of using this technique for tomatoes, which have a much higher potential monetary return. To test this, an experiment on maincrop heated tomatoes was laid down at the Lee Valley Station early in 1964 and a summary of the treatments and results is given below.

Seed of two varieties, Ware Cross and Potentate, was sown on 24 December and planting took place on 5 March, when the first flowers on the bottom truss were open or showing colour. In three compartments the plants were grown throughout their life with CO_2 at the normal level and in three similar compartments with additional CO_2, equivalent to threefold enrichment (1000 v.p.m.) when the ventilators were closed. The CO_2 was applied each day from 14 February until 10 September irrespective of ventilation and of the level of sunshine. Due to a lack of glasshouse compartments, it was not possible to begin enrichment earlier than 20 days before planting and results achieved are mainly an effect during growth after planting out. Picking commenced on 1 May.

Mean yield of two varieties

Treatment	*Total in tons* to 3 July	to 10 September
CO_2 enriched compartments	49·3	72·5
Control compartments	37·1	57·9
Gain from CO_2 enrichment	12·2	14·6

It will be observed that a gain of 12·2 tons had been obtained by 3 July and that this only increased to 14·6 tons by 10 September. Although CO_2 was applied throughout the summer, tests showed that when the ventilators were

more than a quarter open very little enrichment was achieved and as, during the long warm days of mid summer it was necessary to have the ventilators fully open for long periods, this would account for the small effect from CO_2 application after mid June. In large blocks of glasshouses there could be a worthwhile advantage from a moderate CO_2 input at this period, as experience has shown that CO_2 depletion below normal atmospheric level can occur, in such circumstances, even with the ventilators fully open.

The large improvement in yield by 3 July was brought about by a 21 per cent increase in the number of marketable fruits on the first three trusses and also by an increase in the size of individual fruits, there being an 8 per cent greater proportion of 'Pink' grade in the CO_2 compartments.

From the commercial growers standpoint the worthwhileness of CO_2 enrichment will depend upon its effect on net monetary return and a close examination has been made of this aspect. By 3 July, CO_2 enrichment had improved the mean gross return for the two varieties by the equivalent of £2760 per acre. Evidence from studies at other centres indicates that this result would have been obtained if enrichment had been terminated in mid June and up to this date, CO_2 at the rate of 28·2 tons per acre, had been applied. According to the method used and price paid, the total cost would have ranged from £400 to £1200. CO_2 may be used in two ways. It may be used to obtain a similar yield to that obtained previously but with the crops occupying the glasshouse for a shorter period, or it may be used to give a greater total yield by continuing the crop for its normal time, in which case an allowance must be made for the increased cost of marketing the extra fruit obtained. Even when an allowance of, say, 20 per cent is made for extra harvesting, container, carriage and commission charges, there is still an improvement of £1,000–1,800 in the gross margin.

It must be emphasized that the above figures are based on only one year, but experiments carried out previously in Holland and at the Guernsey Experimental Station in 1964, using propane as a source of CO_2, have supported the foregoing results. This work is now being extended to two other Experimental Horticulture Stations and, if the promising results obtained at the Lee Valley Station in 1964 are confirmed, there could be a major breakthrough for the British grower of glasshouse tomatoes as CO_2 could provide the means of materially increasing yield during April–June when tomatoes are in demand, at a price to make CO_2 enrichment economic.

P. G. Allen

NITROGEN TOP DRESSINGS FOR SPRING CABBAGE

It is generally accepted by growers of spring cabbage that generous dressings of nitrogen are necessary in order to promote earlier maturity and heavier yields. The use of nitrogen tends to produce a softer type of growth more susceptible to damage by frost, so that returns from the fertilizer may be less than expected.

Experimental work on the manuring of spring cabbage has been carried out at the National Vegetable Research Station by Haworth, who found that good responses were obtained to dressings up to 270 units per acre nitrogen applied in the form of Nitro-chalk, while more recently experimental work has been started at the Rosewarne and Stockbridge House Experimental Horticulture Stations.

At Rosewarne, representative of areas in the South West where spring cabbage is grown for early cutting in April or early May, results from the Nutrition Reference plots, started soon after the Station was established, indicated the need for nitrogen top dressings. In these experiments two top dressings, each of 105 units per acre nitrogen as sulphate of ammonia and applied in January and February/March, gave large yield increases as long as phosphate and potash were present in adequate amounts.

Further work followed, designed to find out the best type of nitrogenous top dressing to use and the most suitable rates and times of application. Experiments were carried out over four seasons from 1957–58 to 1961–62 testing dressings of 75 and 150 units per acre nitrogen applied in January with and without similar dressings in February/March. Four fertilizers were used, sulphate of ammonia, nitrate of soda, nitrate of potash and urea, the latter being tested in two forms, as crystals and prilled.

Sulphate of ammonia consistently gave the best results, with the nitrate fertilizers, nitrate of soda and nitrate of potash, worst. Urea occupied an intermediate position. The best yields were always given by the heaviest dressings of fertilizer, 150 units in January followed by a further similar dressing in February/March, which often nearly doubled the weight of marketable cabbage harvested.

The reason for the superiority of sulphate of ammonia probably lies in the fact that the fertilizers were applied during the winter when uptake and rate of growth are both slow. Ammonium, and to a lesser extent urea, which is soon converted to ammonium salts after application, is held by the soil while the more soluble nitrates can be easily washed out in periods of heavy rain.

In more recent years, further series of trials were carried out at Rosewarne testing dressings of nitrogen as sulphate of ammonia, first up to 200 and later to 250 units per acre nitrogen, applied in January and again in February. In the latest series, started in 1961–62, dressings up to the heavier rates were tested on a range of varieties. Two seasons' results suggest that, for most of the commonly grown varieties, higher yields are obtained from a total of 500 units than from 400 units per acre nitrogen.

In the north of England spring cabbage is grown for harvesting later in the season, i.e., from late April to early June, depending on the weather. At Stockbridge House an experiment in 1960–61 using Nitro-chalk compared rates up to 280 units per acre nitrogen applied in one dressing on a range of dates from December to March. The best time of application appeared to be February, possibly due to losses in the very wet January weather. For early cutting, 120 units per acre nitrogen were adequate but, for later harvesting of hearted cabbage, increased yields were obtained from dressings up to the maximum rate tested. In 1961–62, a colder dryer season, 140 units per acre were adequate and no differences were obtained between sulphate of ammonia, nitro-chalk and nitrate of soda.

Soil tests in connection with the 1961–62 experiment suggested that at the first cut in mid-May much of the nitrogen applied in top dressings was still in the top soil, a reflection of the cold dry spring. Even at the third harvest date three weeks later, some of the nitrogen still remained in the soil and responses from larger dressings might well have been obtained if the crop had been taken to full maturity.

A summary of all the available results suggests that, in areas of higher rainfall in the west, heavy top dressings are required. For maximum yields, applications of up to 500 units per acre nitrogen may be needed and, at these heavy rates, practical considerations make split dressing necessary. Losses of nitrogen evidently occur under these conditions but these can be reduced by using sulphate of ammonia, the most efficient material of those tested. In dryer areas, the rather limited evidence from Stockbridge House suggests that that form of nitrogen may be less important and that maximum yields may be obtained from the use of smaller dressings, say 120 to 140 units per acre nitrogen applied as a single dressing in February.

J. Webber

SOIL STERILANT EXPERIMENTS AT STOCKBRIDGE HOUSE

During the last ten years a number of experiments have been conducted at Stockbridge House to obtain information on the control of potato root eelworm and root rots on tomatoes. Until recently, the more direct effects of the pest or the diseases on the crop were being investigated, but in experiments now in progress the long-term effect of sterilants on eelworm populations and on the build up of disease on tomato roots during the growing season is being studied. For ease of discussion in this article, experiments carried out prior to 1962 have been grouped into those concerned with the control of potato root eelworm and those with the control of root rots.

Experiments to Control Potato Root Eelworm

The earliest sterilant experiment at Stockbridge House was laid down to compare the efficiencies of four different methods of controlling potato root eelworm:

Steaming every year

Steam and DD in alternate years

EDB (ethylene dibromide) every year

Chloropicrin every year.

The results of this experiment have been fully reported in *Experimental Horticulture*, No. 8. It showed that steam and steam alternating with DD both gave satisfactory control of potato root eelworm, but, because of lower treatment costs, the steam/DD treatment gave a higher margin of profit, higher, in fact, than from any other treatment. Chloropicrin was not successful in controlling eelworm. Indeed, the eelworm count after three years was higher than for any other treatment and nearly 5 times as high as at the start of the experiment. However, this material has been used as a fungicide in later experiments with more success, and, when used in conjunction with DD, appears to enhance the nematicidal effects of the latter.

Following the introduction of metham sodium, two products containing the material, 'Vapam' and 'Sistan', were compared with DD plus formaldehyde. 'Vapam' was applied as a drench and by injection, 'Sistan' as a drench, while DD and formaldehyde were applied by injection and drench respectively.

All the metham sodium treatments were very effective in reducing both the number of cysts and the number of larvae hatched per 100 cysts, though the injection method was not as good as drenching. DD plus formaldehyde was the least effective. Yields from this treatment were low by comparison with the others, although this may have been partly due to the presence of root rots, which were not very well controlled by the formaldehyde drench. Counts made after the crop also emphasized the fact that the use of sterilants, which only partially control potato root eelworm, can result in a build up of the pest to a point where it is impossible to grow a healthy crop.

During 1960 and 1961 various chemicals were tried in observation studies. The more promising included mercuric oxide, carbon disulphide, dazomet and 'Trapexide'. The last two are similar to metham sodium in that their active constituent is methyl isothiocyanate, but in these trials neither dazomet nor 'Trapexide' were quite as effective as metham sodium in controlling potato root eelworm. Plants on 'Trapexide' treated plots looked vigorous and healthy but there were no corresponding increases in yields. Mercuric oxide looked promising in 1960 when used on a small scale, but in 1961, although reducing the eelworm population, it gave very much lower yields than other sterilants. Carbon disulphide was effective both in controlling eelworm and raising yields. In this experiment it was used at three rates of application, the optimum apparently being about 200 gallons per acre.

Experiments to Control Root Rots

The first experiments conducted in 1959 and 1960 investigated the possibilities of controlling root rotting fungi by means of dilute fungicides applied through the low level irrigation lines whenever plants were watered or fed. The fungicides tried were metham sodium at 10 p.p.m. and nabam at 300 p.p.m. or 600 p.p.m. When the roots were examined at the end of the growing season it was found that metham sodium had little effect on the fungi and the roots were severely rotted. Work done elsewhere had shown that the rate of dilution could not be increased without risk of damage to the plants and so this treatment was discontinued. However, application of nabam in this way appeared to have possibilities, for the root systems showed considerably less disease than those from untreated plots. There was no marked increase in yield, but the results were complicated by the presence of potato root eelworm over the experimental site. As a precaution against this happening again the areas of subsequent experiments to control root rots were always injected with DD.

In the following year nabam at 300 p.p.m. was again applied through the low level irrigation lines at every watering and compared with a pre-planting drench of formaldehyde. Some plots also received both treatments. The roots were examined at intervals during the growing period and yield records were taken. Roots from plots which had received formaldehyde alone were severely rotted. The use of nabam appreciably decreased the amount of disease present on the roots, but there was no further decrease when both formaldehyde and nabam were used. As in the previous year there was no difference in yield between any of the treatments.

In the final experiment of this series nabam was again used, but this time at a stronger dilution rate (1 in 250) applied six times during the season at approximately 3-weekly intervals. Zineb was used in a similar manner. Also included were two preplanting treatments of formaldehyde and chloropicrin,

the latter being injected. On this occasion no differences were detected in the root systems. None of the treatments had any measurable effect on the amount of root disease present at the end of the season. The only treatment to have any effect on yield was chloropicrin, which gave a slight increase. As this increase could not be attributed to any improvements in the health of the roots, it may have been due to a release of nutrients from the soil by chloropicrin.

Current Experiments on the Control of Root Rots and Potato Root Eelworm

Previous experimental experience had shown that attempts to measure the effects of root rots were often complicated by the unwelcome instrusion of potato root eelworm and vice versa. Therefore the two long term experiments now running at Stockbridge House have been designed to consider both factors and their interaction. The financial aspects are also being studied.

In one experiment, plants on their own roots or grafted on to a disease-resistant rootstock (in this case rootstock K) are planted into soil treated in one of six ways. The treatments are steam, steam and DD in alternate years, DD, DD plus chloropicrin, metham sodium and carbon disulphide. Of these, DD and carbon disulphide control eelworm, but have little or no effect on soil fungi, while all the other treatments control both in varying degrees. There are also of course untreated control plots.

As might have been expected, the disease resistant rootstock has been of greatest benefit when used in combination with DD or carbon disulphide, and also on untreated plots, although on these, in the second and third years, even grafted plants have given low yields. The use of grafted plants on DD-treated plots increased yields by 50 per cent in 1963, which was more than sufficient to offset the extra cost of grafting. This advantage was maintained in 1964. Similar, though smaller increases in yields and returns, have been obtained from carbon disulphide-treated plots. Where the sterilant treatments control root rots as well as eelworm the increase in yields obtained by grafting, while statistically significant, has not been sufficient to cover the increased costs.

With ungrafted plants, the use of steam or DD plus chloropicrin has given the largest and healthiest root systems. But, as has happened before, yields from plots so treated were no higher than from those where, at the end of the season, the root systems were severely diseased.

The combination of DD and chloropicrin has been the most effective treatment in this experiment for keeping eelworm under control, although the continuous use of chloropicrin by itself, in earlier experiments, resulted in a massive build-up of the eelworm population. With all treatments there has been a gradual increase in the numbers of eelworm cysts in the soil. The increase has been greatest on plots treated with carbon disulphide or DD alone, although these two materials are widely used for the control of potato root eelworm. An unexpected side effect of grafting has been the lower numbers of cysts on plots growing these plants, the only exception to this being in the 1963 crop on unsterilized plots. That year ungrafted plants on unsterilized soil produced small and very badly diseased root systems, which probably meant that fewer cysts were able to mature before the roots died.

Another current experiment compares the effectiveness of metham sodium and dazomet in controlling root rots and eelworm. In this trial the metham sodium is applied to the soil in amounts of water varying from 4 to 80 gallons per sq. yd. The lowest rate of application is forked in.

After two years the results show a definite correlation between the amount of root disease and yields, in that the healthier the root system the higher the yield. This is in marked contrast to the results of other experiments. The recommended quantity of water to use with metham sodium is $2\frac{1}{4}$ gallons per sq. yd, but when the amount of water is increased to 8 gallons per sq. yd the roots are healthier, eelworm control is improved and yields are higher. However, there are practical difficulties in getting the soil to absorb this large quantity of water, and only slightly inferior results are obtained when the rate of application is 5 gallons per sq. yd. So far the application of increased volumes of water has made no difference to the length of time necessary to clear toxic fumes from the soil.

Metham sodium sprinkled on the surface and distributed by cultivation has not given satisfactory control either of root rots or eelworm. Dazomet gave very good results in the first year of the trial, but was less satisfactory in the second year when a considerable amount of root browning occurred and yields were lower than those from other treatments.

N. Margaret Haine

BULK HANDLING OF APPLES

The need for more efficient utilization of labour has led to an increasing use of bulk bins for the mechanical handling of apples.

At Luddington the various aspects of fruit bruising, bin ventilation, depth and design have been considered in relation to the handling and satisfactory storage, of apples under normal refrigerated controlled atmosphere conditions. The work has been carried out in collaboration with Ditton Laboratory and the National Institute of Agricultural Engineering.

Fruit Bruising

The trials have shown that, if the correct techniques of bin use are adopted, there is no greater risk of fruit bruising than occurs with orchard boxes. The simple rules to be observed are that the picking bucket should be lowered to the bottom of the bin before being emptied, that the bin corners are filled first and that subsequent fruit is emptied at the lowest point in the bin to avoid rolling down.

Bin Ventilation

Comparisons of the storage of Cox's Orange Pippin in bins with bottom ventilation varying between 4 and 16 per cent, showed that 4 per cent was adequate and no difference was apparent between bins with a slatted bottom and with an equivalent amount of ventilation as long slots located at the point of join between bottom and sides. Further work has shown that Cox fruit in bins without any bottom ventilation has cooled as quickly, and stored as well, as that in bins with bottom ventilation. For the flotation method of emptying bins, however, gaps in the bottom of the bins are necessary in order to let the water drain away readily.

One aspect of bin ventilation that has still to be resolved is whether the amount of ventilation influences the incidence of storage scald on varieties which are susceptible. An observation comparing the storage of the susceptible variety, Bramley's Seedling, in bins with varying ventilation is being carried out at Luddington during the storage season of 1964–65.

Restricted ventilation achieved by lining bins with polythene has been assessed for the storage of Worcester Pearmain, to see whether the excessive moisture loss in store, associated with this variety, could be reduced. Results over the three years 1961–63 showed that bins lined and loosely covered with 150 gauge polythene, effectively reduced fruit moisture loss from 4–5 per cent to 1–2 per cent without any marked increase in the amount of fruit rot. The fruit in the lined and loosely covered bins was slower in cooling initially and remained 2°F higher than that in orchard boxes, but this did not affect its condition. The method is being compared in commercial stores during the 1964–65 season and the results will show whether firm recommendation can be made.

Bin Depth

Bin depth is limited by the incidence of bruising which occurs on the bottom layers from the weight of fruit above. Bins with an internal depth of 21 inches have proved to be satisfactory; deeper bins have tended to increase fruit damage and are also much more difficult for pickers to empty the fruit into. Pears have a higher fruit density and for them shallower bins are necessary. Prototype designs are on the lines of three nesting sections on a pallet base.

Bin Base Dimensions

For the base dimensions compliance with one of the British and International Standard sizes is desirable, particularly if the fruit is to leave the farm in bins. Of these sizes, the 40 × 48 inches appears to be the most useful. Where bins have to be integrated with existing bushel boxes on pallets for fruit storage, the non-standard size of 43 inches square is useful.

Bin Design

Work on bin design is being carried out at the National Institute of Agricultural Engineering and facilities have been provided at Luddington for fruit to be handled and stored in their 'well-based' bins. Stepped-in side ledges are provided in these bins to eliminate the need for a pallet base, so enabling more fruit to be stowed in a given storage volume. Simple conversion of the forks on fork lift equipment is necessary to handle the bins. Fruit has been handled and stored satisfactorily for two years in these bins at Luddington, although more care is necessary in pushing the forks into position under the bin and the handling equipment cannot be turned until the forks are fully withdrawn. This increases the turning circle required and may mean that wider store doorways would be required.

J. Ingram

NUTRITION OF DESSERT APPLES

The difficulties of translating the results of apple manurial trials and of soil analyses into firm recommendations for the manuring of apples, has long been appreciated. Another approach is to assess what the plant is able to extract from the soil, as reflected in its leaf nutrient concentration, and observe crop and growth responses of trees at known nutrient levels.

In order to provide information on this subject, an Apple Nutrition experiment was sponsored at Efford by Dr. Bould of Long Ashton Research Station. The object was to produce trees of widely different nutritional status, so that the relationship between growth, cropping, and the level of the leaf nutrients could be studied, together with the effects of clean cultivations and grassing down. Cox's Orange Pippin and Worcester Pearmain are the two experimental varieties, with Bowden's Seedling for the guard rows between the plots. All trees are on MII rootstock and were planted as two year olds in the winter of 1954–55 at 24 × 24 ft. Each spring since 1955 every plot has received its appropriate experimental fertilizer applications, with the exception of the nil plots. Fertilizer rates are: nitrogen, 2 cwt of Nitra Shell; phosphate, 3 cwt of superphosphate and potash as 2 cwt of sulphate of potash; these are applied separately and in their various combinations. These rates are not necessarily those recommended in commercial practice. Half of the plots have been retained in arable cultivation since planting, while the remainder were allowed to 'tumble down' to grass, clover only being sown in the summer of 1959.

After planting, the trees grew away very well and the subsequent growth and crop has been very satisfactory, with the best treatment cropping at an average of $5\frac{1}{2}$ bushels per tree for the last three years, whilst the total accumulated yield since 1959 is 23·3 bushels per tree. No noticeable treatment effects were observed before 1958, but since that date very interesting differences have become apparent. The tumble down sward has depressed growth, cropping and leaf nutrient composition. There are also differences due to the fertilizer treatments, and the object of producing trees of widely different nutritional status is rapidly being achieved.

Leaf Analysis 1954–63

Since 1958 leaf samples have been taken from the extension shoots every year in the middle of August, and sent to Long Ashton for analysis. The results have been consistent, with marked effects on the leaf nutrient status by both the cover crop and the fertilizers.

In the presence of sward there has been a reduction in the nutrient status with both Cox and Worcester. This applies since 1960 to potash, where the potassium levels in the leaf are now so low on grass plots which do not receive potash, that severe deficiency symptoms have been recorded for the past two years. The effect of the grass and clover was a reduction in leaf nitrogen in 1960 and 1961 but since then the level rose, so that by August 1962 it was at a similar level to the arable plots. Except in 1961, the tumble down sward has not affected leaf phosphorous.

Application of fertilizers has also influenced leaf nutrient status. Where potash has been applied, there has been an increase in leaf K, with both Cox and Worcester, in every year since 1958. In general, the percentage of potassium in the leaf is falling where potash has been omitted, so that the difference

in the leaf potassium between trees on plots with and without potash is increasing. The only major response to nitrogen was in 1961 with Cox and Worcester, though there was a slight increase in leaf nitrogen in 1962 on Worcester only. There has also been a consistent increase in leaf phosphate where superphosphate has been applied. The levels are steady and it would appear that annual applications have increased the amount of phosphate available to the tree, each year.

Cropping Results 1954–63

The first real crop was in 1959 and since then, apart from 1961, the trees have cropped well, and there appears to be a distinct relationship between cropping and the leaf nutrient status.

The sward has severely depressed the crop, and this effect appears to be much larger than can be explained by a straight competition between the trees and the sward for nutrients. It is more likely that it is due to the combined competition for nutrients and moisture, and possibly also to differences in soil temperature, between the two methods of soil management.

Since the tumble down sward was allowed to develop in 1959, the total accumulated yield for Cox on the NPK plots is 778 bushels per acre compared with 1,311 bushels per acre on the arable plots. Although there has been some loss of colour on the arable, this has been more than compensated for by the increased fruit size and yield.

With the fertilizer treatments, potash has significantly increased the crop, with either Worcester or Cox, in every year except 1961. The main effect has been with Worcester, though there was a crop increase with Cox in 1960 and again in 1963. It is interesting that the only year there was a response to nitrogen was in 1961, when the leaf N was at its lowest and when the ground application of nitrogen increased both the crop and the nitrogen status of the leaf. Since then the level of nitrogen in the leaf has risen and there has not been any response to applications of nitrogen. There are indications that the increase in leaf phosphorous from applications of superphosphate may be reflected in cropping, although the increase was only statistically significant for Cox in 1963. It must be remembered that the Efford soil is very low in phosphate and therefore this result may not have general application, but will be important in assessing the acceptable limits of phosphate levels.

Girth Measurements

The main reason for the reduced yield on the grass plots can be seen in the girth increment figures in the table. In one year alone the girth increment on the arable was almost double that of the grass. This means there is a much greater bearing area on the trees in arable and hence the difference in yield.

Girth increments measured in December each year—Cox's Orange Pippin

	1954–58	1958–60	1960–61	1961–62	1962–63
Grass	No significant difference between treatments	14·3	5·64	Not analysed	5·09
Arable		19·4	10·26		6·43

Although there are already obvious relationships between leaf nutrient status and growth and cropping of apple trees, it would be misleading to give any figures at this stage, as they may have to be modified in the light of subsequent cropping. Under Efford conditions the results of leaf analysis have been remarkably consistent from year to year, and a relationship between tree performance and leaf analysis undoubtedly exists.

E. Gunn

LESS COMMON HARDY FRUITS AND NUTS

It is not generally realized that, in addition to carrying out trials of our common fruits such as applies and pears and maintaining large collections of cultivars (varieties) of these kinds, the National Fruit Trials maintain collections of the less common fruits, such as peaches, nectarines, grapes, acid cherries, and cobnuts and filberts. For convenience these are also classified as 'hardy fruits'. The object of these collections is to demonstrate, or ascertain the possibility or otherwise of, their suitability for commercial cultivation in this country. Although these collections at Brogdale are still quite young, and observations limited, so far none has shown any promise of having a commercial future.

All are planted under field conditions and are subject to the same conditions as an apple or pear orchard. No attempt has been made to give them protection, such as the shelter of a garden or garden wall against which peaches can be satisfactorily grown.

Peaches

The cultivated peach has been derived principally from *Prunus persica* and *P. davidiana*, both natives of China.

The number of cultivars in the National Fruit Trials collection is approximately 90, which includes a few nectarines. These have been obtained from practically every country where peaches are grown commercially, the object being to obtain cultivars from a wide range of environmental conditions. In the majority of cases, cultivars have grown satisfactorily while young, but when the tree approached the fruiting stage all have suffered from the same trouble. This consists of the dying back of the young shoots, which starts about the end of January with the death of the terminal bud, and continues right through to the flowering period, when the only remaining live wood of the previous seasons growth is often only a few inches at the base. The extent of the die-back has varied, but all cultivars have been affected, some so badly that after cutting out the dead wood over a period of two to three years, the tree had insufficient reserve left to survive. This die-back does not appear to be due to infection by any pathogen but seems to be physiological. It may be caused by our autumn not being sufficiently warm to ripen the wood which continues to hold its foliage into early winter, or alternatively our winter temperatures may be too variable to provide the proper chilling requirements of this fruit.

Despite this die-back some cultivars have produced small crops of fruit which have been of reasonable quality and appearance, although not of the same high quality as those imported from Italy. Cultivars which have produced reasonable fruit are Rochester, Redhaven and Veteran.

If this problem of die-back could be overcome, through the breeding of cultivars not subject to this trouble, then peach growing might be a possibility in this country. Incidentally, although the peach flowers very early, frost, which is often described as a hazard, has not been a problem at Brogdale but cold east winds at blossoming time have affected pollination.

Apricot

The apricot is another native of China and the cultivars of this fruit have originated from *Prunus armeniaca*. Apricots have been cultivated in this country since 1500, mainly against a sunny wall in private gardens, but rarely in the open. The fruit flowers very early, sometimes towards the end of February, and pollination can be adversely affected by spring frosts and cold winds.

A small collection of cultivars has been built up at Brogdale and, in addition to those of English origin, there are others which have been obtained from as far afield as New Zealand and North America. Trees of all the cultivars, with two exceptions, show distinct signs of ill-health and the symptoms on certain trees would suggest rather severe virus infection. The exceptions are two seedlings raised at the New York State Agriculture Experiment Station and are grown under the numbers NY 345 and NY 346. Trees of these seedlings are remarkably healthy and vigorous and bore quite good crops of excellent fruit when they were seven years old. These seedlings will continue under careful observation and, if they continue to crop and remain healthy, they might be worth testing in other areas.

Sour Cherries

A small trial of sour cherries has been established consisting of Anglaise Hative, Early Richmond, Montmorency, and Royal Duke. Trees were raised from virus tested material at East Malling Research Station and were planted in the winter of 1958–59. Growth has, on the whole, been good and a good crop was picked in 1964 from the young trees of Early Richmond and Montmorency. There has been very little demand on the market for this type of cherry and, despite being attractively packed, it would seem that the sour type of cherry no longer appeals to the public. The future, if any, of the sour cherry would appear to lie with the canning and preserving industry and not with the fresh fruit market.

Vine

There is little doubt that the Old World Grape, *Vitis vinifera*, is one of the oldest plants in cultivation and was probably grown in Eastern Europe and the Middle East several thousand years ago. It is said to have been introduced into this country by the Romans, and later was widely cultivated in the monasteries until their dissolution. Cultivation was later renewed and there are records of open air growing of vines as far north as Yorkshire. With the introduction of the greenhouse, vine growing became a part of large private establishments and few were grown outside. Recently, however, attempts have been made to grow the vine out of doors in England but up to the present it would appear that, for table grapes, some form of protection is necessary e.g., by growing the vines under cloches.

Another vine which is not widely grown as *V. vinifera* is *Vitus labrusca*, the Fox Grape. Cultivars of this species are widely distributed in America, but most have a peculiar aroma which is not liked by those who have been used to the *vinifera* type.

The *labrusca* types appear to be hardier than those of the *vinifera* and a small collection of cultivars of both species, together with hybrids between the two, have been established at Brogdale, but it is too early to state whether any are likely to succeed in the open without some form of protection. The indications at present are not encouraging.

Cobnuts and Filberts

Both these nuts have been cultivated for a very long time. The cobnut, with its short husk not quite covering the nut, is said to be derived from *Corylus avellana*; the filbert, which is a long nut covered by the husk, is said to have been derived from *C. maxima*. One could add a third type, the large broad Spanish nut, not much grown in this country but imported, which is said to belong to *C. barcelonensis*.

There are several problems in growing these types of nuts. The male and female flowers are borne on different parts of the same tree and pollination is by wind. As both types of flowers do not open together, on some cultivars cross pollination would seem to be necessary. Some bear few catkins (male flowers) and should be interplanted with cultivars which produce plenty of catkins. These nuts also flower early, sometimes about the end of January, and severe late frosts can cause damage to both catkins and female flowers (small crimson tufts). Between thirty and forty cultivars of cobs and filberts have been planted in the National Fruit Trials but, as they take about seven years to come into bearing, it will be some time before a report can be prepared on their behaviour. However, it is hoped that results may be sufficiently encouraging to start small scale planting to determine if cobs and filberts can once again be grown economically in Kent.

J. M. S. Potter

EXPERIMENTS WITH CARNATIONS AT FAIRFIELD

The carnation is not the most important glasshouse crop in the North of England, but there is carnation growing in Lancashire, where the nurseries producing the crop are situated mainly on the coastal strip between the seaside towns of Morecambe and Southport. Here the winter light is better than anywhere else in this industrial part of the country; it is relatively free from atmospheric pollution, and soot deposit on the roof of the glasshouse is not a serious problem. The crop was a new one to Fairfield when the first experiments were set out in the spring of 1963.

The house used for this crop is of the vinery type, constructed of aluminium alloy and fitted with continuous ridge and side ventilators. The house runs in a north-south direction and measures 150 × 30 ft (i.e. covering about 1/10th acre).

Construction of Beds

Eight beds of 70 × 4 ft were constructed, with concrete bases cambered from the centre to allow run-off of any surplus water; the water runs into narrow channels alongside each bed, which connect with a drain at the south end of the house.

These channels were constructed to prevent any seepage of surplus drainage water back into the beds, with consequent risk of spreading infection should any root diseases appear in the crop, and to keep the paths dry so avoiding a high atmospheric humidity in the house.

The sides of the beds are constructed of $\frac{1}{2}$ in. asbestos, 9 in. deep.

Compost

The beds were filled with steamed loam to which had been added peat and $\frac{1}{8}$ in. granite chips, chalk and nutrients to make a compost equivalent to J.I.P. $1\frac{1}{2}$.

Feeding commenced once the plants were well established, using a mixture originally recommended by the Glasshouse Crops Research Institute, of $1\frac{1}{2}$ lb potassium nitrate, and $\frac{1}{2}$ lb urea dissolved in 1 gallon of water and diluted 1 in 250 by volume. This has been used at every watering.

Two experiments have been undertaken, one dealing with the storage of cuttings and plant spacing and the other with date of planting.

Storage of Cuttings

The storing of cuttings is of particular interest to specialist cutting producers as it helps them to equate supply and demand. An important aspect of the work is that the vigour of the cutting, at the time it is taken, is of greater importance than the length of time it is stored. Robust cuttings, taken in August and stored till February before insertion, gave more first grade blooms in the first six months of cropping than those which had been produced in poor winter light conditions and had been rooted direct without storage.

Plant Spacing

The spacings tried were 6 × 3, 6 × 4, 6 × 5 and 6 × 6 inches. At the very close spacings, the foliage and stems of the plants produced a dense mass. The closer spacings gave a small increase in top grade blooms and a much larger increase in second and third grade blooms. The economics of closer planting will depend on the outlet for the additional lower grade blooms and whether the price obtained for them will be sufficient to cover the cost of the additional plants and possible increased cost of managing the denser planting.

Date of Planting

The varieties Pink Sim and White Sim were planted at 6 × 6 in. on four dates 26 March, 29 April, 28 May and 27 June. (See plate IV).

As yield alone is not a true assessment of the economic aspect of the crop, the cash returns from each planting date were compared for the first fourteen months from the planting of each treatment. It was found that the planting made on 29 April had given the highest return, having yielded two heavy

flushes of flowers when the light was good enough to give high quality blooms and the prices on the market were good; the first was obtained September/October while the second flush of flowers coincided with the Easter market.

The next highest return was from the June planting, which was surprising; there had been a long period during the winter when the plants produced very little bloom, but they eventually yielded a very heavy crop of good quality flowers between March and May, which came in at the high price period of Easter and early Summer, so compensating for the six months when practically no bloom was produced.

The lowest returns were taken from the March planted plots; this planting yielded heavily in July and August 1963, but the market prices were low at this time of the year and although the second flush of bloom was marketed the following February and March, it did not compensate for the low prices obtained for the first flush..

To draw any firm conclusions at this stage would be premature, as a different picture may emerge when the full two year cycle is completed for each planting. The information gained on the effect of winter light in this part of the country on yield and quality and the length of time taken from planting to the first peak period of flowering, together with the approximate number of weeks between the flushes of flowers, serve as a guide to plan planting so that these heavy yield periods coincide with the high price periods.

From the results to date it looks as if, in this part of the country, it is more profitable to plant at a time (i.e., the end of April to mid-May) to produce the largest quantity of flowers in Autumn and Spring, rather than aim for the Christmas market, when there is no doubt that light is the limiting factor in producing good quality blooms.

Jean Kinnings

PREPARATION AND FORCING OF FLOWER BULBS

The forcing of narcissus and tulip bulbs for flowering in December, January, February and March, became a major industry around Spalding, Lincolnshire in the period between the wars, which was a difficult one for agriculture. Since 1945, both the acreage of bulbs used for forcing and the area over which the industry is distributed, have greatly increased. Kirton has, in the last three years, been equipped with forcing glasshouses and controlled temperature stores and cabinets, so that experimental work may be done for this increasingly important industry.

For many growers, the forcing programme beings when the bulbs are received from the bulb merchant. Growing conditions and treatment in the field, however, influence both flowering date and quality of bloom obtained in forcing. Every effort is made at Kirton to select stocks of bulbs for forcing experiments that are of uniform size and have had uniform treatment in the field. The grower who forces his own bulbs has some control over date of lifting and thus over the condition of the bulb at lifting. Soil temperatures before lifting have a great effect on the maturity of the bulb, and this has to be taken into account when deciding on the date for lifting. In the cool summers of 1962 and 1963 bulbs matured late and lifting had to be delayed. Difficulties with size and quality of bloom during the subsequent forcing season were

attributed to the effect of low soil temperatures in the month or two before lifting. In 1964, warmer soil conditions in May hastened bulb maturity and it was possible to begin lifting earlier without losing bulb weight.

Many acres of narcissus, Helios, Golden Harvest and Magnificance, are lifted in the last ten days of June for early forcing. Lifting narcissus before the perianth is formed in the developing flower buds has generally been considered to be responsible for small flowers during forcing. This theory was tested in an experiment during the winter of 1963–64.

Results with Narcissus Golden Harvest housed 25 November, 1963

Lifting Date 1963	*I.S.D.* At lifting*	*Storage Treatment*	*Cropping Dates*	*Mean Flower Circumference*
20 June	P1	93°F 21–24 June	20 Dec–10 Jan	9·2 cm
		86°F 21 June–5 July	15 Dec– 2 Jan	9·1 cm
4 July	A2	93°F 5–8 July	16 Dec– 9 Jan	9·5 cm
		86°F 5–19 July	21 Dec–10 Jan	9·5 cm
11 July	G	93°F 12–15 July	18 Dec–13 Jan	9·5 cm
		86°F 12–26 July	17 Dec– 5 Jan	9·4 cm
16 July	G	93°F 19–22 July	22 Dec–14 Jan	8·9 cm
		86°F 19 July–2 Aug	20 Dec–12 Jan	8·5 cm

*Internal stage of flower development

The earliest lifted bulbs produced slightly smaller flowers than the bulbs lifted on 4 and 11 July and a higher percentage of the flower crop was downgraded because of small size. The bulbs lifted on 16 July showed an average flower size smaller than produced by the bulbs lifted on 20 June and an experiment has been planned for 1964–65 forcing season which may throw some light on this, though the higher soil temperatures and earlier bulb maturity in 1964 may prove to be complicating factors.

The bulbs lifted on 20 June and stored at 86°F for 14 days, gave the earliest peak crop of flowers, but otherwise the lifting dates had little effect on the flowering dates until 16 July. Bulbs lifted on this date flowered a little later and a little more slowly than bulbs lifted earlier.

The results shown in the Table also bring out the importance of another factor affecting the forcing of both narcissus and tulip, namely, storage temperature after lifting. Most of the research work on this subject has been carried out in the Netherlands. The construction of controlled temperature stores and cabinets at Kirton, now enables the Dutch recommendations on storage treatments to be tested on bulbs grown under the conditions of the main East Anglia production area. It is now fairly standard practice for growers who wish to force narcissus early to lift and place the bulbs into storage immediately at 93°F for three to five days. After this the bulbs are stored at 63°F until the flower is fully formed and the bulbs are ready for cool store in the normal way. The results already quoted were from an experiment designed to compare storage at 93°F for three days with storage at 86° F for 14 days, both treatments being Dutch recommendations for treating bulbs for early forcing. The bulbs stored at 86°F for 14 days had an earlier peak crop of flowers, particularly from the first lifting, but there were more flowers of the small size grade compared with bulbs receiving 93°F for three days. This reduction in size of flowers following the 86°F storage treatment may be connected with more rapid

flower growth and could perhaps be counteracted by lowering the forcing house temperature for a couple of days. Other storage treatments are being investigated, particularly with tulips, with the object of determining the temperature limits within which the bulbs will make the highest response and the effects on growing and flowering of storage treatments outside these limits.

Usually bulbs are kept at intermediate temperatures of 63°–68°F after controlled warm storage is completed until the flower inside the bulb is fully formed. The bulbs are then ready to go into cool store, the standard temperature for which is 48°F. Last forcing season an observation at Kirton indicated that cool storage at 44°F might give better results with some varieties of tulip, but until further information is gained, the Dutch recommendations of 48°F as the safest temperature should be taken as the standard.

When the bulbs have been in cool store for six weeks they are planted and put on the standing ground, where the soil temperatures may vary considerably with the season. The effect of various rooting temperatures on the subsequent forcing has been investigated. Tulip and narcissus both rooted very quickly at 56°F but when the bulbs were brought into the forcing house they flowered very slowly and over a much longer period than those rooted at 48° and 52°F. The bulbs rooted at 48°F flowered more quickly in the forcing house than those rooted at 52°F, though the latter could possibly have been brought into the forcing house a few days earlier. This would have reduced the difference in mean flowering date between the two treatments and the possibility is being investigated. If they do nothing else, these experiments on rooting temperatures emphasize the importance of cool standing ground conditions while the bulbs are rooting and show the benefit of a cool autumn to the flower forcer. In 1964–65 an experiment is being undertaken to see whether the effects of cold is reversed by subsequent warmth during rooting, and vice-versa, and it is hoped that this will throw further light on the effect standing ground conditions have on subsequent forcing.

Skill in management of the forcing house is very important, but there is much to be learnt about the effects of various conditions and treatments the bulbs receive before they reach the forcing house. An important object of the work, which Kirton's new facilities should make possible, is to find answers to the problems in the preparation and conditioning of bulbs for forcing, and to develop and demonstrate new and improved techniques.

G. Baines
Elizabeth D. Turquand

EVALUATING NARCISSUS VARIETIES FOR COMMERCIAL USE

The Rosewarne collection of narcissus varieties is, at flowering time, a popular sight, and, to the casual observer, most of the varieties appear equally good. On the performance records, however, many of them have been marked down as unsuitable for commecial use. The varieties are judged purely for their value as crops grown under the special conditions of the south west and we tend to put extra emphasis on certain characters which are important in this area.

Flowers must be well shaped and of good colour, durable in the field and long lasting in water. They must not have a poor consitution and rate of bulb increase should be good.

All varieties are grown at standard spacing in ridges and as they are cultivated by commercial methods, weeds are controlled solely by spraying. Newly introduced narcissus are grown first in isolation until they have been checked for eelworm and other pests and diseases. After 2–3 years they become acclimatized and then they are ready for evaluation in the main collection.

Date of flowering is highly important here. Cornwall is an early district and earliness usually pays. New varieties need to be at least as early as those which they may replace. Absolute earliness for all types of flower is not essential but each variety should be early for its type. The spread of the flowering season affects labour needs; one which completes its flowering in 7–10 days can be picked in 3–4 stages and this can be done economically; one with a longer spread of flowering will need more labour.

The flower stem should be long enough, with the bud standing above the leaves, so that the leaves do not beat against it in high winds. It must be strong without being thick and awkward to bunch. The neck of the flower must also be right for bunching. The flowers are sold as flat bunches packed in a box. Short necked and long necked flowers together do not easily make a substantial good looking bunch.

In the box they must also look well coloured. Distinct bright colours are preferred to those with muddy shades and those which change colour as they develop present a patchy appearance.

It pays to give the customer good value by supplying long lasting flowers and the vase life of all narcissus is now being recorded so that those with a short flower life can be marked down. The vase life is measured in a room at constant temperature and humidity, so that fair comparison can be made between narcissus flowering at different times. Vase life cannot be judged from the substance of the flower. A solid looking flower may have a life of only 4–5 days while flimsy ones may last twice as long.

The flower yield is measured in the second year of growth when the crop has recovered from hot water treatment. The second year's flower crop provides most of the financial return for the whole crop and the yields range from 150,000 to 400,000 per acre.

The other important return from the crop is bulb yield. A grower needs a good increase of bulbs so that he can maintain or increase his area of bulbs, and have some to spare for sale. Although Cornish growers are primarily flower growers, bulb sales are a profitable sideline, and varieties, which make a good weight of saleable bulbs, are appreciated.

The detailed records of cropping and varietal characteristics are being published in a leaflet (available on request at Rosewarne) and this will be revised from time to time. The object will not be to recommend special varieties but rather to provide the details, so that the grower can pick the varieties to suit his needs. Such information has not been available in the past when growers buying bulbs were sometimes influenced more by good salesmanship than by good advice. While making no general recommendations on varieties, the reader may wish to have an indication of the varieties that are suggested for commercial use. The following are some which could replace or supersede present day commercial varieties of narcissi.

Division (in R.H.S. classification)	*Variety*	*Flowering Date*
1a	Dutch Master	27 February
2a	Lizard Light	27 February
2a	Pleasant	4 March
2a	St. Keverne	4 March
3b	Barrett Browning	4 March
2a	Armada	6 March
2a	Mexico	7 March
1a	Burgemeester Gouverneur	14 March
2a	Red Devon	14 March
8	Glorious	16 March
4	White Lion	24 March
1a	Irish Luck	25 March
2a	Missouri	30 March
2b	Kilworth	4 April
3b	Winifred van Graven	4 April
4	Primrose Beauty	6 April

L. W. Wallis

TWO SERIOUS DISORDERS IN WINTER CAULIFLOWER

An experiment at Rosewarne over the past four seasons has aimed at investigating the causes of stem rot (or hollow stem) and leaf edge scorch in Roscoff winter cauliflower (broccoli). Prior to this it had been clearly established in experiments, that stem rot is not caused by a deficiency of boron, since up to three times the commercial rate of borax had been applied without a successful control.

Recent lines of investigation have concentrated on a possible correlation between high rates of inorganic nitrogen and the ensuing rush of growth, culminating in cell breakdown and collapse of the plant tissue, hence the presence of stem rot and in some cases leaf scorch. The results to date indicate that stem rot is due to the inability of the internal parenchymatous tissue to keep up with rapid increases in stem diameter and is not due to a trace element deficiency. It is possible that the ability of the internal tissues to keep pace with the increasing stem diameter is, at least partially, a function of the genetical make up of the plant.

Statistical examination of the figures for the incidence of stem rot on different varieties shows that significant differences occur between varieties heading at the same time.

It has also been shown in plant breeding material at the Station, that certain progenies appear more susceptible to leaf scorch than others, and this suggests that here again it may be primarily a genetical problem. However the condition can be aggravated by high rates of inorganic nitrogen and this confirms the findings of Jenkinson and Campbell (*Plant Pathology* 6, 92–4: 1957).

Time of application of nitrogen, in particular on varieties thought to be susceptible to the two disorders, is thought to be of great importance. It is not possible at this stage to give firm recommendations as to quantity and time of application, as this largely depends on the existing state of fertility of the field in question.

It is of interest to note however, the following points in relation to nitrogen manuring which have emerged from the experiment. Yields of curd do not automatically rise with increasing applications of nitrogen, and once the optimum dressing has been given, further applications merely depress the yield of marketable heads by increasing the amount of stem rot and scorch. Results suggest that much of the nitrogen applied commercially may be wasted, especially when the winter cauliflower crop follows early potatoes from which there is often a considerable residue of nitrogen carried over. Provided the general level of fertility is satisfactory, further applications of nitrogen later in the season have little effect on yield where an early or mid-season (i.e., October–February heading) variety is used. The greater the total quantity of nitrogen, the higher was the incidence of stem rot, and generally the earlier the nitrogen was applied, the more stem rot occurred.

Audrey M. Williams

SPACING OF BROAD BEANS

White-eyed longpod broad beans have been grown under contract for canning for a number of years at Terrington. In common with local practice, they are hand sown in shallow ridge and furrow work at a row spacing of 28 inches and seed rate of about 10 stones per acre. Lack of information about this crop and interest in the effect of increasing the rectangularity of seed spacing, led to a small scale replicated trial which was started in 1963. In this trial seed was hand dibbled in 'on the square' spacings of 12, 8½, 7 and 6 inches, giving a range of seed rate of 9·6 to 37·6 stones per acre. Reducing the spacing from 12 to 8½ inches gave a yield increase of 24 per cent and an increase in gross margin of 13 per cent. Closer spacing produced no further yield increase, decreased pod size, thereby increasing picking costs, and was uneconomic because of the high seed cost.

In 1964 seed rates of 8·6, 11·2 and 17·2 stones per acre were compared, each one being produced by appropriate seed spacings either in 18 inch row work or by 'on the square' planting. There were, in addition, plots sown at the middle seed rate in 28 inch rows. The trial grew well until ten days before harvest, when it succumbed to an attack of aggressive chocolate spot which rapidly defoliated the beans and stopped further growth. This attack was more severe at high seed rates and on plots planted on the square rather than in rows. In these circumstances, the high seed rate did not produce sufficient yield increase to pay for the extra seed and the best cash return was obtained from the two lower seed rates when sown in wide rows.

J. L. Short

RANUNCULUS AS A CUT FLOWER IN THE SOUTH WEST

When ranunculus were first grown at Rosewarne they were one of a number of flower crops grown with a view to finding some alternative for the anemone crop. It was soon apparent, in the first season, that they were not so hardy,

neither was flower production as continuous as with the anemone. There was very little flower production during the winter months, although the plants themselves survived the milder winters to produce a reasonable spring crop.

The first trials were carried out using Claremont Hybrids, the most popular variety with the flower growers in the south west. Small one year old 'claws' were used, planting at weekly intervals from 27 July to 31 August in the 1960–61 season. The first planting was the only one which flowered in November and early December; the 7 August planting produced the highest number of blooms in January and February but were extremely susceptible to weather conditions at that time of year, much more so than anemones. The two mid-August plantings gave their highest crop during the months of March and April and the three latest plantings reached their peak in April. Few, if any, blooms were worth marketing before March. During the time of peak crop the price obtained per bunch was between 8*d.* to 1*s.* similar to that of anemones. All plants had died down naturally in June, even those of the latest planting, the cropping period in this case covering only about 8 weeks. Details of this trial can be found in the 7th Rosewarne Annual Report, 1961.

Unlike anemone corms, the ranunculus claws are recoverable or can be left down for two years. It was thought that they might be susceptible to anemone downy mildew, but no infection was found when planted on land following anemones. When left down for two years, the flowering period follows the natural seasonal pattern and occurs from May to July, no flowers being produced during the winter months. After lifting the resulting claws can generally be split into two but these, when replanted, are slower to flower than one year claws raised from seed.

Residual herbicides can be used provided they are applied pre-emergence. A slight check to growth will occur but simazine up to 1 lb per acre can be used, also chlorpropham at ½ lb, with reasonably good results. Diuron and related compounds can cause severe damage as will a post-emergence application of any residual herbicide.

A number of varieties popular in the south of France were grown for one season but these did not prove hardy enough for winter or spring work. Among these were some small flowered types, the flower heads being little more than 1 inch in diameter but all extremely double and uniform in colour. It is doubtful whether they would have been as popular on the English market as the larger and more colourful paeony flowered varieties already grown. Some of the strains of *Ranunculus asiaticus* were promising, particularly *R. asiaticus superbissimus*. The colour range was good and the percentage of doubles higher than with Claremont hybrids. Stems, however, were a little shorter than Claremont hybrids but flower production was slightly higher.

With all varieties there were still the seasonal effects on peak cropping periods and none of the varieties tried would ever give the same performance as anemones. There would always be a place for ranunculus on the small family holding, on a similar scale to polyanthus or wallflowers, but anything more than this would incur too high a production cost in return for a flower crop which is likely to remain among the lower priced flowers on the market.

A. Elizabeth Jeff

MATTED ROWS AND GIBBERELLIC ACID ON STRAWBERRIES AT TERRINGTON

Although strawberries are fairly commonly grown in matted rows in the Wisbech area, growers in many parts of the country prefer spaced plants. At Terrington, the two methods of growing the crop have been compared, for two years, on all the principle commercial varieties and in every case matted rows gave a higher total yield of marketable fruit. With one exception (Cambridge Vigour in the first year) this was also true of the yield of dessert fruit. Although the position was not quite so clear cut with early yield, the early yields of the two important early varieties under test, Cambridge Rival and Cambridge Prizewinner, were appreciably greater from matted rows. Now that weed control in matted rows has been made easier by herbicides, these provide an easier and cheaper method of growing strawberries than spaced plants, and it appears that the method could, with advantage, be more widely adopted.

The effects of gibberellic acid on the strawberry crop in experiments in this country have been much more variable that elsewhere. In order to obtain information in this area, one of the six replicates in the variety trial at Terrington was treated in 1963 and again in 1964 with a 45 p.p.m. solution of gibberellic acid applied at 60 gal per acre an estimated six weeks before flowering. Best results were obtained from treating the matted rows, and compared with adjacent untreated blocks, the total yield of marketable fruit from Cambridge Favourite was increased by just over 1 ton per acre in both years. Merton Princess showed a very worthwhile response also, but the yield of Cambridge Rival was considerably depressed in both years. The effect of the treatment was most noticeable in the first two weeks of picking, when prices are usually high, and differences in yield established then were generally maintained for the rest of the season, although in some varieties untreated plots tended to catch up later on.

Results from spaced plants were less consistent, but were sufficiently encouraging to justify further work on the subject.

R. H. Jarvis

AUTOMATIC WATERING OF MUSHROOMS

Following the work of P. B. Flegg of the Glasshouse Crops Research Institute, a system of automatic watering of the casing layer of mushroom beds has been developed at Fairfield. Flegg worked with mushrooms in trays, and wicks made of viscose were dipped into plastic troughs filled with water and laid on top of the casing layer. As the casing dried out water moved by capillarity from the troughs along the wicks, replaced that which had been lost.

At Fairfield, where the shelf system of growing is used, much larger units are watered i.e., individual beds each having an area of 25 sq. ft (5 × 5 ft). In the tray system of growing the distince across the beds is relatively short and capillary movement from the water troughs along one edge of the trays was adequate to keep up with losses. It was considered, however, with the larger dimensions of the beds used at Fairfield, that a system should be devised whereby wicks from any edge of the beds should only water half the area of that bed. The following system was adopted: ½ inch plastic (solid P.V.C.) tubes

were run under the centre of each shelf with an upright 2 inch plastic tube placed in the opening between the tiers of shelves, the two types of tube being joined by T pieces (Plate III upper). These tubes were used to convey the water and six wicks were inserted into the open end of each 2 inch upright, 3 wicks being laid half way across one bed and 3 being laid half way across the next bed. Plate III lower illustrates this. The end upright tube was fed by means of a drip nozzle adjusted to keep the system filled with water. The surplus water from the top layer of shelves fed the layer underneath and from the bottom shelf it fell on to the floor (Plate III lower).

The material used for making the wicks was, initially, viscose, but this disintegrated after about three weeks and was replaced by nylon felt. This latter material functioned very well and after five weeks showed no signs of rotting; it has subsequently been used for other crops, after sterilization.

Yields from the wick watered beds were equal to those from hand watered beds, the main advantage being the saving of labour and removing the need for personal judgement as to when to water and how much. Where baterial spot is a problem due to persistent water droplets, deposited when hand watering, wick watering should be of benefit.

D. A. G. Jones

HYBRID LILIES AS CUT FLOWERS AND POT PLANTS

Extensive work by plant breeders in America has resulted in the development of varieties of hybrid lily, which are vigorous and produce blooms of excellent quality in a wide range of colours.

Early in 1963 an investigation was started at Lee Valley with the object of testing the potentialities of several of these varieties under conditions in Britain, and of assessing suitable techniques for growing high quality blooms over a long season.

Heated Glasshouse Production

In these trials, the tigrinum hybrids have proved to be very suitable for early flowering as cut flowers or pot plants over the period March to late May. These hybrids, obtainable in colours ranging from lemon yellow to deep red, have relatively short stems, which are particularly desirable for pot plant growing, and they produce large umbels bearing many individual flowers. The varieties Cinnabar, Enchantment, Harmony and Joan Evans were prolific in bloom production and proved to be very suitable in both years.

The results have indicated that it is possible to forward the bulbs a second season for cut flower purposes, if they are grown singly in 6 inch size pots and if a resonable length of stem is allowed to remain, when cutting the flowers during the first season, to permit the completion of the growth cycle. In the second season, the bulbs can be grown in the same compost provided frequent liquid feeding with nitrogen and potash is given to maintain satisfactory growth.

In 1964 a study investigating methods of growing the bulbs to give well balanced compact pot plants was begun and in the initial trial the effect of short day treatment was examined, as research in U.S.A. had shown that this

could be beneficial in reducing stem length. From the commencement of growth the varieties Enchantment and Harmony were given a restricted daylength of seven hours and this resulted in a decrease of only $1\frac{1}{2}$ inches in stem length and of $\frac{1}{2}$–1 inch in the length of the stems of the individual flowers. It is reported that the application of a restricted daylength is more successful in bright springs, so it is understandable that only a small effect was obtained in the very poor light conditions that prevailed in the early part of 1964. This work will be continued and further experiments will also include the use of growth regulator chemicals.

Outdoor Production with Temporary Protection

Another method of growing lilies is to plant the bulbs in double span Dutch light frames with sides approximately 24 inches high, consisting of polythene on a framework to give plenty of light. The lights are removed in early May when the plants are almost touching the glass.

This technique has been used successfully at Lee Valley in 1963 and 1964. The bulbs were planted in the frames in March 1963 and in both years the spikes of flowers have been cut on stems ranging from 12–33 inches in length, according to the height of the variety. By this means it is hoped to obtain cut flowers from the same bulbs for several seasons with temporary protection during the period November–May each year.

The tigrinum hybrids were the first to flower, followed by Limelight, Pink Perfection and Bright Star as mid season varieties, and Imperial Silver and New Jamboree as later varieties. This range of varieties has given a succession of good quality blooms from mid May to the end of July and little weather damage was sustained provided the flowers were cut before they were completely open.

Conclusion

It must be emphasized that the growing of hybrid lilies for sale as cut flowers or pot plants is new in Britain and that demand at present is limited and variable. It is considered that these lilies, in a wide range of colours and types, could have a useful place especially during the period from March to the end of July, and that there is scope for the gradual expansion of sales as pot plants, as cut flowers for decorative purposes on medium length stems, and for make-up work with individual flowers on short stems.

D. E. Green

DORMANCY BREAKING IN HYDRANGEAS AND ASTILBES

These two plants seem to offer the same problem to the nurseryman; both appear subject to a winter dormancy that must be broken before the plants can be forced. If that dormancy can be broken early then plants can be marketed earlier and possibly command the higher prices associated with earliness.

Hydrangeas: Periods of cold storage and marketing dates

Number of days in cold store 35°F (1·7°C) from 24 October, 1963	*Date taken from cold store to forcing house 60°F*	*Number of days at 60°F (15·6°C)*	*Marketing date*	*Total number of days to produce a marketable plant*
10	4 November, 1963	153	5 April, 1964	163
20	13 November, 1963	136	28 March, 1964	156
30	23 November, 1963	119	21 March, 1964	149
40	3 December, 1963	114	26 March, 1964	154
50	13 December, 1963	108	30 March, 1964	158
60	23 December, 1963	101	2 April, 1964	161

Hydrangeas

At Stockbridge House in the 1962–63 season, plants moved into a forcing temperature from a cold frame in mid-November flowered at about the same time as plants moved in mid-December. In other words different periods in natural cold storage, plus different periods of forcing, add up to the same length of time and result in the same marketing date. American work showed an identical trend; after 15 days cold storage plants forced in 105 days, a total of 120 days, whereas plants cold stored for 30 days required 90 days forcing. When plants have been subjected to sufficient cold then any further period in store is time wasted. Thus 45 days cold storage required 82 days to force, a total of 127 days, and a week longer than the two previous treatments. This is confirmed by experiments at Stockbridge House in 1963–64 which gave the results shown in the table. Two cold storage temperatures 35°F (1·7°C) and 40°F (4·4°C) were used in this experiment, but there was no difference in the results. It may well be more economic for a nurseryman to maintain a forcing temperature for 101 days and accept a marketing date a week later rather than force for 114 days.

Astilbes

Similar results have been found with astilbes (Plate IV), though the total time to force at 60°F (15·6°C), was successively reduced with increasing cold storage periods.

Thus after 28 days at 35°F (1·7°C) plants needed 134 days of forcing: total 162 days.

After 42 days at 35°F plants needed 114 days of forcing: total 156 days.

After 56 days at 35°F plants needed 93 days of forcing: total 149 days.

Unlike hydrangeas, astilbes responded more to different degrees of cold, 42 days at 35°F reduced the forcing time by 5 days compared with 42 days at 40°F (4·4°C).

A further treatment has been a subjection to a brief period (2–10 days) of a temperature of 85°F (29·4°C). This heat treatment has reduced the time to marketing by up to 12 days. American work showed a reduction of 32 days in the forcing period after maintaining a temperature of 110–111°F (43·3–43·9°C) inside the root for 1 hour.

Experiments with both plants are continuing with a view to determining the precise time at which dormant plants should be taken indoors for forcing, in the same manner as is done now for rhubarb.

S. Jubb

New Items of Interest in the Experimental Programme

EFFECT OF CUTTING TIME ON CEREAL YIELDS

Interest in the effect of time of harvesting cereals has been increased by recent developments. The practice of moist grain storage in hermetically sealed silo has permitted farmers to combine grain at 25 per cent moisture without excessive expenditure on drying. Some work on Experimental Husbandry Farms has shown that occasionally higher yields on a dry matter basis have resulted, particularly where strong winds occur before the grain reaches normal ripeness. Delays in combining after the grain is fit are inevitable in many seasons, and the variety chosen can affect the amount of grain lost in these circumstances. A start has been made with studying the comparison between cereal varieties at different times of cutting.

BROADCASTING CEREAL SEEDS

Cereal drilling can be a time consuming job, especially under unfavourable weather conditions. With the reduction in the labour force on many arable farms, ways to speed up this operation are of topical interest. One possibility is to broadcast the seed grain, for example by a fertilizer distributor, and then cover it by suitable cultivations. This method was studied at High Mowthorpe in 1964; although yields were promising, conventional drills gave higher yields in the trial. Further work is needed on the best sequence of cultivations to achieve consistent results. Even so, the method may not be applicable in the lightest soils, or with very dry seedbeds.

PCA FOR SUGAR BEET

PCA (5 amino: 4 chloro: 2 phenyl: 3 pyridazone) is a new herbicide for sugar beet, and may be applied as a pre- or post-emergence spray. Over a wide range of soil types the selective properties of PCA have proved promising, but observations at Gleadthorpe Experimental Husbandry Farm in 1964 showed that the degree of weed control depended to a large extent on the method and time of application.

Three methods of pre-emergence treatments consisted of (1) an overall spray to the seedbed followed by harrowing before drilling; (2) a post-drilling spray with seedbed incorporation by means of light harrows; and (3) a post-drilling spray without harrowing. The post-emergence spray was applied when the beet had at least two true leaves. PCA was applied at the rate of $3\frac{1}{2}$ lb of wettable powder in 37 gal of water per acre.

The most successful method of weed control was seedbed incorporation of PCA before drilling. By comparison with the unsprayed area, this treatment reduced the weed population by 95 per cent. There was a good control of the dominant weeds, namely mayweed, spurrey and chickweed. *Polygonum* spp appeared more resistant but there were too few of these weeds to assess the effectiveness of the herbicide.

PCA sprayed after drilling, but before emergence, controlled 75 per cent of the weeds found on the unsprayed area and was therefore not as efficient as the seedbed application. The effect of the herbicide was not improved by harrowing into the soil.

Application of PCA post-emergence was the least successful of the methods tried (70 per cent control of the weeds present), but timing of the spray is critical at this stage and in 1964 the optimum time to spray the weeds coincided with the susceptible stage of the sugar beet.

At Gleadthorpe, the future intention is to compare PCA with other chemicals commonly used on sugar beet and also to find out whether band spraying of PCA, combined with the use of precision drilled monogerm seed at 3 and 5 inch spacing, can reduce or eliminate the cost of hand hoeing.

FODDER AND CEREAL RATIOS IN BEEF PRODUCTION

The advocates of beef from concentrates or beef from grass products, are usually expert in their respective fields. The farmer who is neither, or suspects that the best way lies between these two extremes, will be interested in a new series of trials now beginning at four Experimental Husbandry Farms and the Norfolk Agricultural Station. Autumn born calves are reared from twelve weeks old on three diets. One of these is unrestricted concentrate, another is two-thirds of the ration as concentrate and one-third as fodder, and the last is one-third concentrate and two-thirds fodder. Calves from all three treatments are turned out to grass during the summer, but one group from the all-concentrate ration continue through to slaughter on that system. In the second winter calves from the unrestricted concentrate group are put back on to that system, while each of the other two diet groups is divided into four sets; the first set is put on an unrestricted concentrate diet; the second receives two-thirds concentrate and one-third fodder; the third set receives one-third concentrate and two-thirds fodder and the fourth is put on an unrestricted fodder-only diet. All animals will be killed at the weight and finish commercially acceptable for the particular type of animal.

Records will include live weight, food consumption including fodder digestibility studies and an assessment of the carcasses. Gleadthorpe and the Norfolk Agricultural Station will use Friesian steers, Drayton, Liscombe and Rosemaund will use Hereford × Friesian steers, while Rosemaund will also use Hereford × Friesian heifers, on this comparison of ten different combinations of feeding system.

SOW FEEDING

Experimental work on this subject is being carried out at various universities and research stations. This is supplying useful information, but more work needs to be done before reliable recommendations on feeding rates can be given.

Before 1960, no sow feeding work had been attempted on the Husbandry Farms. Since then Boxworth and Great House Experimental Husbandry Farms have conducted experiments comparing three levels of feeding for lactating sows. These levels were: 3 lb meal + $\frac{1}{2}$ lb per piglet (low), 4$\frac{1}{2}$ lb meal

+ ¾ lb per piglet (medium) and 6 lb meal + 1 lb per piglet (high). During the lactation period of eight weeks the sows were not allowed access to grass, while during pregnancy they were kept on grass and fed 5 lb meal per day rising to 6 lb on the 85th day. The sows were kept in the trial for five lactations.

The results suggest that the low rate of lactation feeding was inadequate; at both farms eight week weights of the piglets were poor and the health of some of the sows suffered. The medium rate gave good results at both centres, but the effect of the high rate was less consistent: piglet performance was improved at Boxworth, whereas at Great House this was not the case and some infertility occurred in the sows.

It is apparent that these results only apply to sows fed 5 to 6 lb of meal per day at grass during pregnancy. Alterations to the level of pregnancy feeding might influence the response to lactation feeding. This suggests that it is really necessary to study rates of feeding over the whole breeding cycle of the sow, in order to discover the most economical feeding system.

A trial to investigate this subject was planned in 1963 and is now in progress. The treatments combine three feeding levels during pregnancy (4, 6 or 8 lb of meal per day) and two while suckling (7 or 10½ lb per sow with 4 piglets, plus ½ lb for each extra piglet). The sows are being kept on concrete or bare ground throughout pregnancy and lactation, in order that complete nutrient intakes can be recorded. Each of the sows is being kept in the experiment for four pregnancy/lactation cycles and their litters are being weaned at eight weeks. Long term experiments of this type are difficult to conduct. In a single 40 to 50 sow herd the number of breeding gilts available for allocation to the trial at any one time is relatively few. This means that the trial must be carried out within several herds at once, if sufficient replicates are to be put through within a reasonable time. This problem is being overcome by conducting the trial at six Experimental Husbandy Farms: Boxworth, Bridget's, Great House, High Mowthorpe, Terrington, and Trawscoed. Liaison is being maintained with the Rowett Research Institute, who are running a similar series of trials in Scotland.

SHEEP DENTITION

In a natural course of events a ewe's teeth deteriorate as she grows older, until eventually she becomes 'broken mouthed' and loses the ability to forage efficiently. The reasons for the different speeds at which this occurs are not fully understood, but as there is wide variation in the rate of deterioration, both between flocks and between individuals within a flock, it appears that both heredity and environment play a part.

The first sign of approaching deterioration in a ewe's teeth is often for the incisors to begin protruding in front of the dental pad. As this 'under-shooting' proceeds, the incisors fail to make proper contact with the dental pad and they then become overgrown and loose in the gums. A dental operation has been devized to arrest the development of this condition by using a high speed drill to grind the 'under shot' incisors down until they once again locate with the dental pad. The Agricultural Research Council has organized a series of trials to test the technique. High Mowthorpe and Liscombe are co-operating in this work by providing ewes, which are given a detailed dental inspection every six months. Half of the ewes showing the early stages of dental deterioration

are then treated and the remainder are left as controls. Records of the ewes' live weight, lambing performance, fleece weight and quality are maintained in addition to the dental history. These records will be used to assess the effectiveness of the technique in maintaining the treated ewes in a productive state so that the economics of sheep dentistry can be appraised on flocks being maintained under very different environments.

MARKETING NARCISSUS IN BUD

Nearly all of the early narcissus from Cornwall and the Isles of Scilly are picked as buds. During the growing season gales are frequent and, if left on the plant, most of the flowers would be damaged before they opened. Flowers for sale are cut at the 'gooseneck' stage when the bud bends over from straight-up to horizontal (Plate IV); the buds are then taken into sheds where the established practice has been to place them in water buckets and to allow them to open before packing and dispatch.

A narcissus flower under average living room conditions will have a vase life of about a week from the time it opens; if it opens in the growers' packing shed, its useful life starts there and all the time spent in transit, at the wholesale market, and the retail shop has to be deducted from this. This transit time is often up to two days and the stay at the shop can be considerable, so that it is not surprising that the flowers can be nearly dead when the customer gets them home. Growers in the south west, whose flowers are most affected by long travelling periods, have the greatest incentive to adopt practices which will extend flower life and make their flowers more valuable.

The first most obvious solution would be to send the flowers as buds and this in fact answers most of the problem. Buds picked at the gooseneck stage and showing colour can be packed and sent through the distribution system to the retailer before they open. If the flowers are picked at the right stage they develop to full size and colour after opening and last for their full vase life. There are other advantages in this method of marketing, the buds can be packed more economically and they can also be stored at 35–45°F for short periods without affecting the life of the flowers later on when they have opened. A few varieties, notably Narcissus Soleil d'Or and double narcissi, do not open satisfactorily from buds and these require special treatment.

Having read of the benefits of dispatching flowers in the bud the reader is entitled to ask why the practice is not more widespread. The answer is unfortunately, that the growing side of the industry is ahead of the distribution side and the consumers. There is little consumer demand for buds and while this is so the retailers are unlikely to risk buying flowers which might be in their shops longer than usual. At this point, it seems, a little expenditure on publicity and education would be well worthwhile.

USE OF COLD STORED RUNNERS FOR STRAWBERRY PRODUCTION UNDER GLASS

Strawberries have been forced in heated glasshouses for many years, and the traditional method has been to lift runners in late summer and pot these into 5 inch or 6 inch size pots. The plants are then stood outdoors and kept growing actively until late October, when the pots are placed on edge or brought into a cool building until required for forcing in December or January.

Following upon the work by Dr. Guttridge at the Scottish Research Institute a few years ago, it has now become possible to store freshly lifted runners in polythene bags at a temperature of 28–30°F and to use these runners for planting at different times of the year. In 1962 a trial was begun at Lee Valley to test the possibilities of this technique for the production of forced strawberries. Runners lifted in November and given cold storage treatment for a minimum of six weeks before potting in early January, have been compared with runners lifted and potted in early October and stood in the open, and also with plants left in the runner beds until early January before potting. The plants from all three methods have been given identical treatment from this latter date when they were taken into the glasshouse to begin forcing. Large sized runners with seven or eight fully developed leaves were used and over the three years, 1962–64, the following mean yields have been obtained.

The variety Cambridge Vigour gave 6·2 ounces per plant from October lifted runners, 5·8 ounces from cold stored runners and 6·0 ounces from runners lifted in January. Cambridge Favourite did not crop at such a high level and comparable figures were 4·2 ounces, 5·1 ounces and 4·1 ounces.

These results indicate that satisfactory results can be obtained by forcing large sized runners potted immediately prior to being taken into the glasshouse in January. Cold storage ensures that plants will be available for forcing if freezing conditions should prevent the lifting of runners at the end of December, and in a mild autumn this technique provides plant material in a suitable condition for satisfactory forcing.

STRAWBERRY VARIETIES FOR MAIDEN CROPPING

Cambridge Vigour and Merton Princess have for two years been the heaviest yielding varieties at Rosewarne when grown for the first year crop. Planted in mid-August at 3 × 1 ft both gave heavy crops of dessert fruit. On maiden plants of Vigour the fruit is easier to pick, being produced on longer stalks than on Princess. Favourite, Early Cambridge, Redgauntlet, Talisman, Prizewinner and Rival all cropped reasonably well but the last two varieties are less consistent in their behaviour. Royal Sovereign produced only a light crop, even from early planting and, unless there is some special reason for growing it under similar conditions to those of Rosewarne, it is not likely to compete with Vigour. Regina, the earliest variety, has up to the present given low yields.

DEPTH OF PLANTING OF EARLY POTATOES

Early bulking and maturity of crop in early potato areas is generally an important consideration. Choice of the right variety for the district, and the adoption of suitable techniques, play an important part in producing the crop for early lifting. Planting depth is known to have an effect on early bulking and maturity of Arran Pilot when planted 2 × 1 ft apart in early spring on loam soils at Rosewarne in West Cornwall. For three years, planting on the surface with a shallow covering of 2 in. of soil has been compared with planting in shallow furrows 3 in. deep with a shallow covering of soil, and planting in furrows 5 in. deep and covered with high ridges. The two shallower plantings have given more mature and heavier crops at earlier liftings than the deep

planted seed. When lifted somewhat later, the deep-planted seed has again produced less mature and less regular crops than the shallow planted plots, although occasionally it may have approached in weight that of one of the shallow treatments. The shallow planted crops have not so far been unduly affected by greening or by dry conditions.

CAUSE OF 'TOPPLE' IN TULIPS

A condition known as 'Topple', in which the flower stem weakens and the head drops over on its side, sometimes occurs in forced tulips. A surprising outbreak of the disorder occurred in Elmus tulips grown in sand culture experiments at Kirton. These tulips were receiving the standard Long Ashton nutrient solution supplying calcium and all micro-elements in adequate amounts for the plants. Only the nitrogen, phosphorous and potassium were varied experimentally. Topple occurred in all treatments not receiving nitrogen and affected 100 per cent of the flowers where the low nitrogen treatment was combined with high potassium. Although the calcium given had previously been considered adequate, it is now known that the tulip plant's calcium nutrition is affected in the disorder and its prevalence on low nitrogen plants suggests that the nitrogen supply, as well as calcium, should be considered when precautionary treatments are given for Topple. A suitable material to use would be calcium nitrate.

BULB PLANTING IN PLASTIC NETS

This is a method, developed at Rosewarne, which facilitates complete lifting of small batches of bulbs enabling them to be kept together and identified, and is therefore particularly useful in the maintenance of variety collections.

The bulbs are loaded into the nets by hand, being put through a sleeve (from which the plastic net is played out) on to holes in a jig which is pushed along a roller conveyor beneath the loading position (Plate II). The net is closed by a knot at each end. Equal spacing is maintained by plastic clips round the net between bulbs. The net is identified by means of an aluminium or plastic label fastened to it with aluminium wire. With narcissus bulbs, the nets can serve as containers when the bulbs are hot water treated for stem and bulb eelworm.

They can be planted by hand in beds or ridges and can be lifted by several types of mechanical lifters. The bulbs in the net become planted on their sides. This does not affect them adversely and they grow and develop normally in the nets.

The plastic net is avilable as tubes in several sizes. One should be chosen which will retain the small bulbs (offsets) produced as the original bulbs grow. When the nets are lifted the plastic clips can be broken off, the end of the net untied and the bulbs emptied out for cleaning and grading. The net has so far lasted satisfactorily in the soil for one year and seems likely to remain sound for at least another season.

Experimental Husbandry Farms and Horticulture Stations

Centre	*Acreage*	*Main Farming and Experimental Activities*
HUSBANDRY FARMS		
Arthur Rickwood E.H.F., Mepal, Ely, Cambs.	150	Intensive arable farm on black fen peat. Fen wastage studies; cereals, root crops: and some horticultural crops of the area.
Boxworth E.H.F., Boxworth, Cambs.	858	Mixed farm on boulder clay. Friesian cattle, cross-bred ewes and Large White pigs. Rearing and feeding dairy stock; cereal husbandry.
Bridget's E.H.F., Martyr Worthy, Winchester, Hants.	1,035	Large-scale arable farm with leys on chalk. Ayrshire and Friesian herd. Cross-bred ewes and Landrace × Large White pigs, management and feeding of dairy stock; growing cereal crops, growth of leys and conservation.
Drayton E.H.F., Alcester Road, Stratford-on-Avon, Warwickshire.	469	Mixed farm on Lias clay. Beef cattle feeding; cross-bred ewes. Utilization of grassland for beef and lamb production; grass conservation.
Gleadthorpe E.H.F., Welbeck Colliery Village, Mansfield, Notts.	493	Light sand arable farm. Rearing Friesian steers. Poultry. Production of arable crops; irrigation; maintenance of fertility; feeding and management of laying poultry.
Great House E.H.F., Helmshore, Rossendale, Lancs.	460	High lying Pennine farm in industrial area. Ayrshire cattle, Derbyshire Gritstone sheep, Large White pigs; poultry; management of dairy cattle. Production, utilization and conservation of grass. Rearing and housing of laying hens.
High Mowthorpe E.H.F., Duggleby, Malton, Yorks.	1,080	Arable farm on high lying chalk. Cross-bred beef cattle; cross-bred ewes; Large White pigs. Production of cereal and root crops; rearing and feeding of cattle and sheep.

Centre	*Acreage*	*Main Farming and Experimental Activities*
Terrington E.H.F., Terrington St. Clement, King's Lynn, Norfolk.	311	Large White and Essex pigs. Production of arable crops, including cereals, potatoes, sugar beet, soft fruit, and tomatoes under glass. Pig breeding and management.
Liscombe E.H.F., Dulverton, Somerset.	495	Upland grass farm adjoining Exmoor. North Devon and cross-bred cattle; Clun, Welsh and cross-bred sheep. Breeding and rearing of cattle and lambs. Production and utilization of grass and fodder crops.
Pwllpeiran, E.H.F., Cwmystwyth, Aberystwyth, Cards.	3,100	Welsh mountain farm. Welsh sheep and Welsh Black cattle. Management of cattle and sheep; provision of winter fodder; shelter.
Rosemaund E.H.F., Preston Wynne, Hereford.	437	Mixed farm on heavy red sandstone soil. Hereford and cross-bred cattle, cross-bred sheep. Breeding and management of beef and beef × dairy cattle. Production of arable crops and hops.
Trawscoed E.H.F., Trawscoed, Aberystwyth, Cards.	808	Mixed farm on shale-type soils with moor. Freisian cattle and a Hereford suckler herd. Welsh and half-bred sheep; Large White pigs. Rearing and feeding dairy stock; growth and utilization of leys; breeding and management of sheep and pigs.

HORTICULTURE STATIONS

Cleppa Park E.H.S., Cardiff Road, Newport, Monmouthshire.	68	Production of fruit, vegetable and flower crops under local conditions in the open, under Dutch lights and cloches, and in glasshouses.
Efford E.H.S., Lymington, Hants.	376	Nutrition and variety trials with top and soft fruit; vegetables including potatoes; tomatoes and other crops in heated and cool glasshouses; flower crops; irrigation.
Fairfield E.H.S., Greenhalgh, Kirkham, Preston, Lancs.	22	Glasshouse crops including tomatoes, lettuce and flowers; mushrooms; blackcurrants and raspberries.

Centre	*Acreage*	*Main Farming and Experimental Activities*
Kirton E.H.S., Boston, Lincs. (Holland).	104	Bulb production and forcing. Vegetable variety testing.
Lee Valley E.H.S., Ware Road, Hoddesdon, Herts.	26	Glasshouse crops including tomatoes, cucumbers, lettuce, chrysanthemums; flowers in the open; mushrooms; mobile glasshouses.
Luddington E.H.S., Stratford-on-Avon, Warwicks.	230	Apples, plums and soft fruit, pest and disease control, nutrition and root-stocks; vegetables and flowers; mobile glasshouses; irrigation; weed control.
Rosewarne E.H.S., Camborne, Cornwall.	109	Early bulb and vegetable crops including potatoes; mobile glasshouses; shelter. Bulb conditioning and flower storage.
Ellbridge E.H.S. (Sub-Station) Hatt, Saltash, Cornwall.	5	The study of early crops produced in the Tamar Valley.
Stockbridge House E.H.S., Cawood, Selby, Yorks, West Riding.	161	Vegetable crops including rhubarb. Top and soft fruit; fixed and mobile structures; shelters; mushrooms; flowers.
National Fruit Trials, Brogdale Farm, Faversham, Kent.	185	Testing and classification of all types of top and soft fruit.

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N·A·A·S EXPERIMENTAL FARMS & STATIONS

● Husbandry Farm ▲ Horticulture Station △ Horticulture Sub-Station

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